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TREES OF CALIFORNIA

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By WILLIS LINN JEPSON.

THE TREES OF CALIFORNIA. A working manual for the field. 125 original illustrations. Price $2.50.

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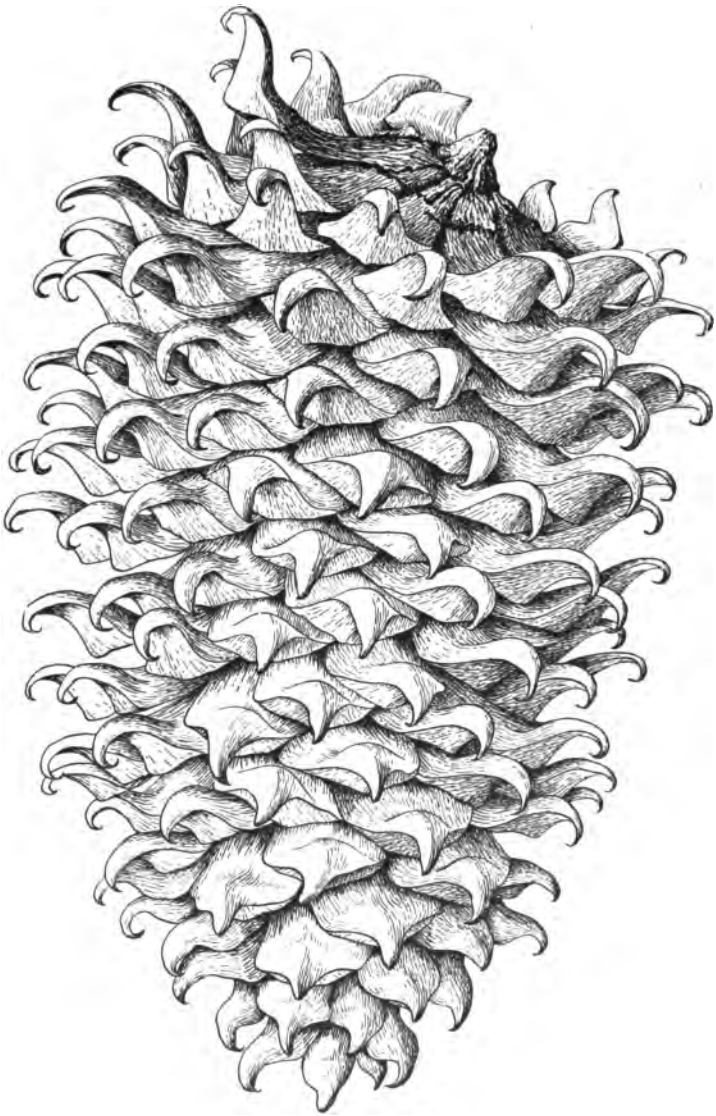

Fig. 1. BIG-CONE PINE (*Pinus coulteri* Don.). *a*, Cone. ½ nat. size. This species bears the largest and heaviest cones of any pine. The cones are well marked by the long talon-like appendages or curving spurs to the scales. See page 67. (Drawn by Miss Mary H. Swift.)

THE TREES OF CALIFORNIA

BY

WILLIS LINN JEPSON, PH. D.

Assistant Professor of Dendrology in the University of California, Life Member of the California Academy of Sciences, Sierra Club, and American Breeders' Association, Member of the Commonwealth Club of California.

Illustrated with one hundred and twenty-five original figures

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THE HICKS-JUDD COMPANY
San Francisco

TO MY FRIENDS.

Frederick Folger Thomas, President of the Gwin Mine on the Mother Lode; William Anderson Scott Foster, Manager of the Northwestern Redwood Company; Ralph Hopping, naturalist on the South Fork of the Kaweah; Charles Russell Johnson, President of the Union Lumber Company; Carl Purdy, student of the Coast Range chaparral; Alden Sampson, literateur and mountaineer; Ralph Platt, notary on the edge of the Vaca Mountains but more than that, born naturalist—

To these, this book is dedicated in appreciation of their helpful aid and in memory of days and nights in mining camps in the cañon, logging camps in the forest, and pack-train camps on the mountain trails of Alta California.

We had not proceeded far from this delightful spot, when we entered a country I little expected to find in these regions. For about twenty miles it could only be compared to a park, which had originally been closely planted with the true old English oak; the underwood, that had probably attended its early growth, had the appearance of having been cleared away, and had left the stately lords of the forest in complete possession of the soil, which was covered with luxuriant herbage, and beautifully diversified with pleasing eminences and valleys; which, with the range of lofty rugged mountains that bounded the prospect, required only to be adorned with the neat habitations of an industrious people, to produce a scene not inferior to the most studied effect of taste in the disposal of grounds.—[Captain George Vancouver, commander of the English naval ship Discovery, in the Santa Clara Valley, November 20th, 1792.]

*I have seen the trees diminish in number, give place to wide prairies, and restrict their growth to the border of streams; * * * have seen grassy plains change into a brown and sere desert; * * * and have reached at length the westward slopes of the high mountain barrier which, refreshed by the Pacific, bear the noble forests of the Sierra Nevada and the Coast Range, and among them trees which are the wonder of the world.*—ASA GRAY, in 1872, after his first journey to California.

Preface.

Dr. James Bryce, British Ambassador to this country, once addressed informally a body of students at the University of California on the conduct of life. After speaking of those things necessary to real success in life he urged his hearers each to cultivate some interest beyond their life work or profession which would serve, like the study of some branch of botany, zoölogy or geology, as an intellectual recreation and as a resource from excessive cares of the day's or week's work.

The advice, while not new, was happily given. The lack of popular interest in the natural history sciences, failing some other cultivated interest, is unfortunate both for the individual and for the community. While this book from the standpoint of utility is designed primarily to provide a working manual* of the native trees in small compass for use in the field by the horticulturist, farmer, cattleman, lumberman, mountaineer, forester, teacher or traveler who wishes to learn something of the botany of California trees, their names and their geographic and economic interest, it is also given out with still another purpose.

*This book is not a condensation of and should not be confused with the author's Silva of California (Mem. Univ. Cal. No. 2), a more technical treatise. The present book was partly written in 1902 and taken up and completed in January to March, 1909. A few notes have since been added.

In the preparation of certain chapters the author owes not a little to inspiration derived from the friendship of the late Sir Dietrich Brandis, long-time member of the Imperial India Council as Inspector-General of Forests, than whom there is no more heroic figure in the history of forestry. From Augustine Henry, Esq., the botanical explorer of China, now Lecturer in Forestry in Caius College, University of Cambridge, I have received, regarding our California forest species, a multitude of critical questions which have been suggestive and stimulating. Helpful material of California trees has been kindly placed at my disposal by my colleague, Professor H. M. Hall, by Mr. George D. Butler of Siskiyou, by Mr. Walter Fry of Sequoia Park, and by not a few other friends and correspondents.

The line drawings are mainly the work of the late Miss Mary H. Swift, who was at the time of her death rapidly developing into a botanical artist of unusual promise.

The author also takes pleasure in expressing thanks to his friend, Arthur W. Ryder, Assistant Professor of Sanskrit in the University of California, who most generously read the entire proof.

The natural surroundings of Californians are singularly rich and varied. A scientific interest in at least certain features of our natural environment, as for example the trees, shrubs or herbaceous plants, directs one to useful and agreeable intellectual activity. Accurate and detailed knowledge of even a small area lifts the possessor out of the commonplace and enables him directly or indirectly to contribute to the well-being and happiness of his community.

The author, therefore, cherishes the hope that these pages may be an inspiration to some who have opportunity to take up special studies of our trees for the sake of the intellectual pleasure and cultivation to be derived from such an avocation. The number and diversity of the native trees of California, their habits, places of growth, times of seeding, relation to different soils, reaction to fire and a host of such matters offer a most attractive field to the botanist. These things do not form a very "practical" study to be sure, but they are the basis of other things which are "practical" and such study, moreover, offers a means of mental enjoyment which is cultivation in the best sense. In spite of our worship of the "practical" it is being more widely recognized that the cultivated man with keen intelligence and a broad and liberal outlook is getting more out of life and is really more practical after all than the so-called practical man who has narrowed his interests to those which concern his immediate personal needs, who is not stirred by the lure of the unknown, and who has "locked his door against the ideals" and imaginations of humanity.

This book, then, distinctly makes appeal to those who would enjoy the botany of the native trees and, perhaps challenged to explore the mysteries of their relationships, discover a world of interest in all those matters which serve to contribute to their classification—for their proper classification, a much desired object, is in reality an illuminating and organized compendium of their detailed structure, their congenital ties, their life history and their ancestry.

Willis Linn Jepson.

UNIVERSITY OF CALIFORNIA,
Berkeley.
March 27, 1909.

A logged REDWOOD area. The standing trees are "culls", with second-growth below them. Reproduced from Breuer's drawing by permission of Mrs. Volney D. Moody of Berkeley.

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THE TREES OF CALIFORNIA,—LEADING CHARACTERISTICS.

The number of species of trees in California which may properly be called such is 94. Of the total 43 are coniferous trees, 3 are palm or palm-like trees, and 48 are broad-leaved trees. The most interesting and striking features of the silva of California relate to its composition, the geographical distribution of the species and their biological history.

California is most remarkable for its development of coniferae, not only in number of species (which exceeds any other equal area), but in size of the individual trees and their forestral development. This statement is peculiarly true of the true pines of which we have 17 species. The oaks may well be contrasted with the pines. Of true oaks we have 14 species, nearly as many as the pines, but their forestral development is comparatively insignificant, except for the Tan Oak, and their biological interest is considerably less.

List of Species of California Trees.

1. PINE FAMILY (Pinaceae).

Silver Pine (Pinus monticola Don).
Sugar Pine (Pinus lambertiana Dougl.).
White-bark Pine (Pinus albicaulis Engelm.).
Limber Pine (Pinus flexilis James).
Foxtail Pine (Pinus balfouriana Jeffrey).
Hickory Pine (Pinus aristata Engelm.).
Yellow Pine (Pinus ponderosa Dougl.).
Tamrac Pine (Pinus murrayana Balf.).
Beach Pine (Pinus contorta Dougl.).
Big-cone Pine (Pinus coulteri Don).
Digger Pine (Pinus sabiniana Dougl.).
Torrey Pine (Pinus torreyana Parry).
Parry Piñon (Pinus parryana Engelm.).
One-leaf Piñon (Pinus monophylla Torr.).
Bishop Pine (Pinus muricata Don).
Monterey Pine (Pinus radiata Don).
Knob-cone Pine (Pinus tuberculata Gord.).
Douglas Fir (Pseudotsuga taxifolia Britt.).
Big-cone Spruce (Pseudotsuga macrocarpa Mayr).
Tideland Spruce (Picea sitchensis Carr.).
Weeping Spruce (Picea breweriana Wats.).

Coast Hemlock (Tsuga heterophylla Sarg.).
Mountain Hemlock (Tsuga mertensiana Sarg.).
White Fir (Abies concolor Lindl. & Gord.).
Lowland Fir (Abies grandis Lindl.).
Red Fir (Abies magnifica Murr.).
Noble Fir (Abies nobilis Lindl.).
Santa Lucia Fir (Abies venusta Koch).

(2) REDWOOD FAMILY (Taxodiaceae).

Big Tree (Sequoia gigantea Dec.).
Redwood (Sequoia sempervirens Endl.).

(3) CYPRESS FAMILY (Cupressaceae).

Incense Cedar (Libocedrus decurrens Torr.).
Canoe Cedar (Thuja plicata Don).
Port Orford Cedar (Chamaecyparis lawsoniana Murr.).
Gowen Cypress (Cupressus goveniana Gord.).
Monterey Cypress (Cupressus macrocarpa Hartw.).
Sargent Cypress (Cupressus sargentii Jepson).
MacNab Cypress (Cupressus macnabiana Murr.).
Modoc Cypress (Cupressus bakeri Jepson).
California Juniper (Juniperus californicus Carr.).
Desert Juniper (Juniperus utahensis Lemm.).
Sierra Juniper (Juniperus occidentalis Hook.).

(4) YEW FAMILY (Taxaceae).

Western Yew (Taxus brevifolia Nutt.).
California Nutmeg (Torreya californica Torr.).

(5) LILY FAMILY (Liliaceae).

Joshua Tree (Yucca brevifolia Engelm.).
Mohave Yucca (Yucca mohavensis Sarg.).

(6) PALM FAMILY (Palmaceae).

California Fan (Washingtonia filifera Wendl.).

(7) WILLOW FAMILY (Salicaceae).

Yellow Willow (Salix lasiandra Benth.).
Red Willow (Salix laevigata Bebb).
Black Willow (Salix nigra Marsh).
Arroyo Willow (Salix lasiolepis Benth.).
Nuttall Willow (Salix flavescens Nutt.).
Velvet Willow (Salix sitchensis Sanson).
Common Cottonwood (Populus fremontii Wats.).
Black Cottonwood (Populus trichocarpa Hook.).
Aspen (Populus tremuloides Michx.).

WALNUT FAMILY (Juglandaceae).
California Black Walnut (Juglans californica Wats.).

(8.) BIRCH FAMILY (Betulaceae).
White Alder (Alnus rhombifolia Nutt.).
Red Alder (Alnus rubra Bong.).
Water Birch (Betula occidentalis Hook.).

(9.) OAK FAMILY (Fagaceae).
Valley Oak (Quercus lobata Neé.).
Oregon Oak (Quercus garryana Dougl.).
Blue Oak (Quercus douglasii H. & A.).
Mesa Oak (Quercus engelmannii Greene).
Island Oak (Quercus tomentella Engelm.).
Maul Oak (Quercus chrysolepis Liebm.).
Coast Live Oak (Quercus agrifolia Neé).
Interior Live Oak (Quercus wislizenii A. DC.).
California Black Oak (Quercus kelloggii Newb.).
Tan Oak (Pasania densiflora Oerst.).
Giant Chinquapin (Castanopsis chrysophylla A. DC.).

(10.) LAUREL FAMILY (Lauraceae).
California Laurel (Umbellularia californica Nutt.).

(11.) PLANE FAMILY (Platanaceae).
Western Sycamore (Platanus racemosa Nutt.).

(12.) ROSE FAMILY (Rosaceae).
Mountain Mahogany (Cercocarpus ledifolius Nutt.).
Trask Mahogany (Cercocarpus traskiae).
Islay (Prunus ilicifolia Walp.).
Oregon Crab Apple (Pyrus rivularis Dougl.).
Catalina Ironwood (Lyonothamnus floribundus Gray).

(13.) PEA FAMILY (Leguminosae).
Mesquite (Prosopis juliflora DC.).
Screw Bean (Prosopis pubescens Benth.).
Palo Verde (Cercidium torreyanum Wats.).
Smoke Tree (Dalea spinosa Gray).
Desert Ironwood (Olneya tesota Gray).

(14.) BUCKEYE FAMILY (Sapindaceae).
California Buckeye (Aesculus californica Nutt.).

(15.) MAPLE FAMILY (Aceraceae).
Big-leaf Maple (Acer macrophyllum Pursh).
Box Elder (Acer negundo var. californicum Sarg.).

CACTUS FAMILY (Cactaceae).
Suwarro (Cereus giganteus Engelm.).

DOGWOOD FAMILY (Cornaceae).
Mountain Dogwood (Cornus nuttallii Aud.).

HEATH FAMILY (Ericaceae).
Madrona (Arbutus menziesii Hook.).

ASH FAMILY (Oleaceae).
Oregon Ash (Fraxinus oregona Nutt.).
Leather-leaf Ash (Fraxinus coriacea Wats.).
Arizona Ash (Fraxinus velutina Torr.).
Dwarf Ash (Fraxinus anomala Wats.).

BIGNONIA FAMILY (Bignoniaceae).
Desert Willow (Chilopsis saligna Don).

HONEYSUCKLE FAMILY (Caprifoliaceae).
Blue Elderberry (Sambucus glauca Nutt.).

Only species which in their typical adult form are trees of timber type or approximating thereto are included in the above list. This statement is a fair expression of my working rule. It is not followed with strictness because, for one reason, there is no absolute distinction between shrubs and trees since they pass into each other.

In a number of families descriptions of the shrub species have been included in order to complete the account of the family. These appear in small type with the species names as side-heads in black-face type.

Peculiar and Local Species.

The silva of California is remarkable for the number of species peculiar to California or which here attain their greatest development. It is also interesting for the number of extremely local species—species which are confined to a single or few localities or have a restricted range.*

The number of species strictly peculiar to California is 18, a relatively large number. The number of species which may be called typically Californian is also large, namely 52. By typically Californian is meant that a species has here its greatest development and is restricted to our area, or ranges beyond it no great distance or only in a feeble or uncertain manner.

**See section on* "Arboreal Islands" and the "Klamath Mountains."

J. N. LeConte photo.

Fig. 2. Forest on floor of Yosemite Valley, composed mainly of YELLOW PINE, INCENSE CEDAR, WHITE FIR, BLACK OAK. SUGAR PINE and BLACK COTTONWOOD also occur. The distant high ridges are forested mainly with YELLOW PINE, SUGAR PINE, White Fir and INCENSE CEDAR. See pages 18, 56, 62, 93, 112 and 173.

J. N. LeConte photo.

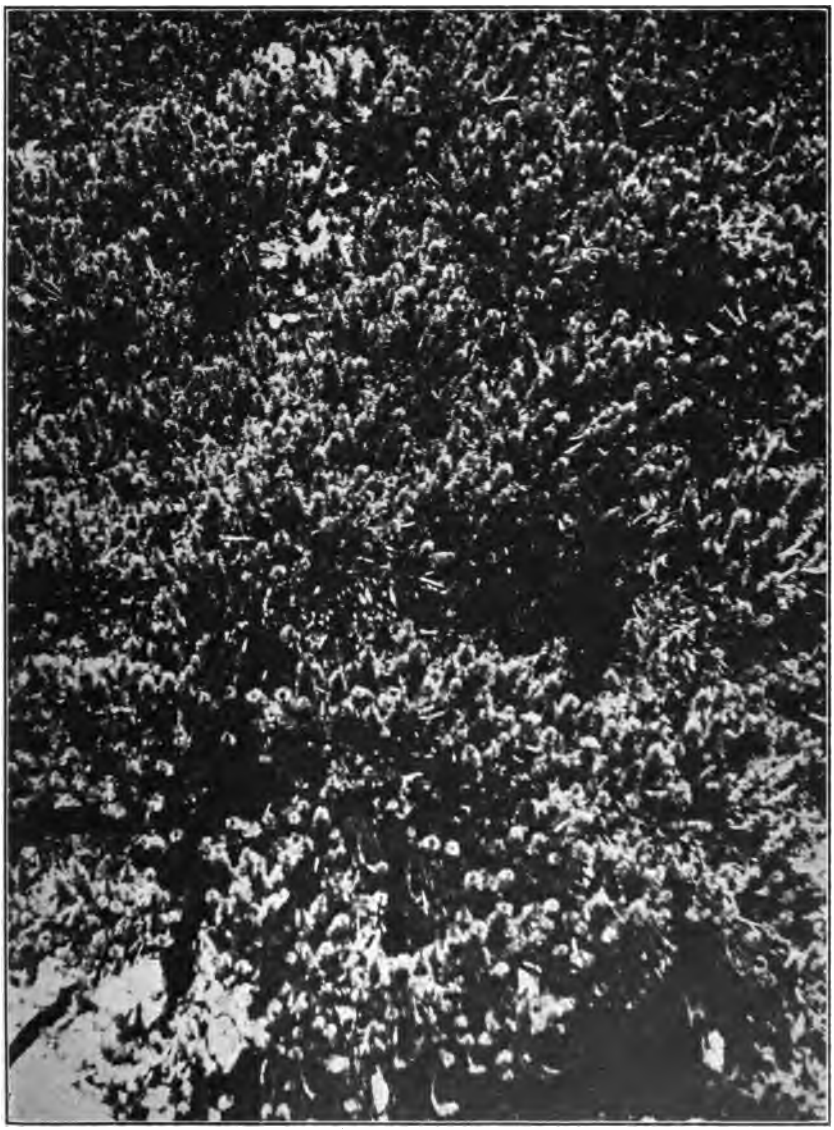
Fig. 3. Upper portion of main timber belt, southern Sierra Nevada, on Bubbs Creek at West Vidette. This forest is composed of JEFFREY PINE, FOXTAIL PINE, WHITE-BARK PINE, TAMRAC PINE and MOUNTAIN HEMLOCK. See pages 18, 58, 60, 65, 66 and 90.

L. E. Hunt photo.

Fig. 4. SIERRA JUNIPER (*Juniperus occidentalis* Hook.). Tree on South Yollo Bolly, North Coast Ranges. See pages 19 and 124.

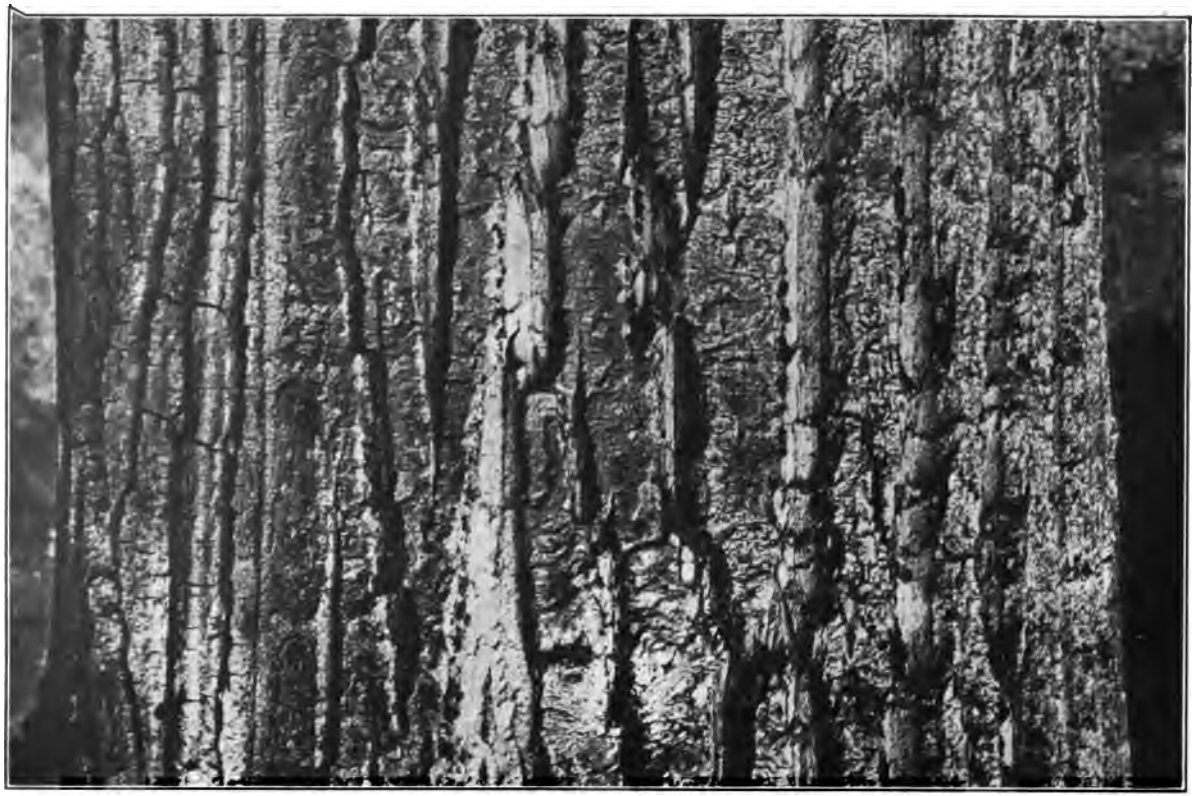
W. L. J. photo.

Fig. 5. FOXTAIL PINE (*Pinus balfouriana* Jeffrey). Characteristic pure forest of this species on the Whitney Plateau near Whitney Creek, southern Sierra Nevada, 9,000 feet altitude. See pages 18 and 60.



W L. J. photo.

Fig. 6. FOXTAIL PINE (*Pinus balfouriana* Murr.). Lower side of crown, showing its density, the branches numerous and compacted. Bubbs Creek, South Fork Kings River. See pages 18 and 60.



P. E. Goddard photo.

Fig. 7. BLACK COTTONWOOD (*Populus trichocarpa* T. & G.). Characteristic trunk bark. Long Valley, Mendocino County, this tree 80 feet high, the trunk 50 feet tall and 2½ feet in diameter at 4½ feet above the ground. See pages 18 and 142.

Geo. L. Smith photo.

Fig. 8. Upper portion of main timber belt in southern Sierra Nevada, headwaters of Clover Creek, looking towards Mt. Silliman from the Giant Forest—Kings Cañon trail. RED FIR, TAMRAC PINE, JEFFREY PINE and SILVER PINE. See pages 18, 56, 65, 66 and 96.

F. W. Anderson photo.

Fig. 9. ONE-LEAF PIÑON (*Pinus monophylla* Torr.). Exceptionally tall tree *near Piute Mountain,* Kern County. See pages 20 and 72.

The distinctive character of the silva of California is emphasized by a comparison of it with the silva of the Eastern United States. These silvas have only two species in common, namely the Aspen and the Black Willow.† The California silva has, however, marked relationships with the silva of Oregon and Washington and in a less degree with the silva of the Rocky Mountains.

Nearly all our species of Pinaceae and Cupressaceae are peculiar to the Pacific Coast. Although about 13 species range east to the Rocky Mountains only a few of these have any considerable development or extension in that region. All of our species of Fagaceae are peculiar to the Pacific Coast save one only, Quercus chrysolepis Liebm., which ranges east in a limited manner through Arizona to New Mexico.

In the following list of typically Californian species, the species strictly peculiar to the State are marked with an asterisk.

TYPICALLY CALIFORNIAN TREES.

Sugar Pine.
*Foxtail Pine.
Yellow Pine.
Big-cone Pine.
*Digger Pine.
*Torrey Pine.
Knob-cone Pine.
Monterey Pine.
Bishop Pine.
Weeping Spruce.
Big-cone Spruce.
Red Fir.
White Fir.
*Santa Lucia Fir.
*Big Tree.
Redwood.
Incense Cedar.
*Monterey Cypress.
*Gowen Cypress.
*Sargent Cypress.
*McNab Cypress.
*Modoc Cypress.
Sierra Juniper.
*California Juniper.
*California Nutmeg.
*California Fan Palm.
Joshua Tree.
Mohave Yucca.
Red Willow.
Yellow Willow.
Arroyo Willow.
Fremont Cottonwood.
*California Walnut.
White Alder.
Red Alder.
Giant Chinquapin.
Tan Oak.
*Valley Oak.
*Blue Oak.
Mesa Oak.
Maul Oak.
Coast Live Oak.
Interior Live Oak.
Black Oak.
California Laurel.
*California Buckeye.
Western Sycamore.
Islay.
*Catalina Ironwood.
Madroña.
Blue Elderberry.

†Compare special description of these species: see index.

Forest Provinces.

On account of the peculiar topography of the State, the height, direction and ramification of the mountain ranges, the varying rainfall due to altitude or distance from the ocean, and the variations in temperature, the different species of trees are each limited to rather sharply defined climatic zones. Large areas, particularly at lower altitudes away from the coast or in the deserts, are treeless or support only scattered trees. For convenience of citation of range under the description of the species the State is divided into five forest provinces which, while very convenient in this connection, are at the same time physiographically natural divisions. These are the Sierra Nevada, North Coast Ranges, South Coast Ranges, Sacramento and San Joaquin Valleys, and Southern California.

1. Sierra Nevada.

The Sierra Nevada is a lofty and unbroken mountain range, 500 miles in length and 6,000 to 15,000 feet in height, its western base rising from a plain that is only about 500 feet above sea-level. The eastern slope is very abrupt and about 5 to 15 miles wide. The western slope, which bears the main timber belt, is about 40 miles wide and is comparatively gradual. The foothills, 500 to 3,000 feet, are barren or support only a scattered but characteristic growth of Digger Pine, Blue Oak and Interior Live Oak. The main timber belt begins at 2,000 feet in the north and 5,000 feet in the south and consists in its virgin condition of a most magnificent stand of coniferae, the four most abundant species being Yellow Pine, Incense Cedar, White Fir and Sugar Pine, the preponderance of individuals in the order named (Fig. 2). Black Oak is usually found with Yellow Pine in the lower part of the Yellow Pine belt or just below it. Black Cottonwood usually occurs in cañon bottoms. Big Tree is also found in this belt and is often the dominant species in restricted areas, although always associated with the four conifers just named. The upper portion of the main timber belt is characterized by the presence of the Silver Pine, Red Fir and Tamrac Pine (Fig. 8). Above the main timber belt occur the timber line trees, most of them with conical trunks excessively thickened at base, short branches, and irregular *or broken tops.* These include the Whitebark Pine, Foxtail

Pine, Mountain Hemlock and Sierra Juniper (Figs. 3, 4, 5, 6 and 10).

The different timber belts or zones on the western slope of the Sierra Nevada with their average altitudinal limits and leading species may be briefly summarized as follows:

1. Foothill belt, 500 to 3,000 feet; Digger Pine, Blue Oak, Interior Live Oak.

2. Main timber belt, 3,000 to 6,500 feet; Yellow Pine, Black Oak, Sugar Pine, White Fir, Incense Cedar, Big Tree.

3. Upper portion of main timber belt, 6,500 to 9,000 feet; Red Fir, Silver Pine, Tamrac Pine, Jeffrey Pine.

4. Timber-line belt, 9,000 to 11,000 feet; White-bark Pine, Sierra Juniper, Mountain Hemlock, Tamrac Pine, Foxtail Pine.

2. North Coast Ranges.

The North Coast Ranges comprise the ranges from San Francisco Bay north to the Oregon line. The main feature of this forest province is the remarkable development of the Redwood Belt, from the lumbermen's standpoint the densest body of timber in the world (Figs. 12 and 13). The Redwood is the dominant tree in the Redwood Belt, the subordinate species being Douglas Fir, Lowland Fir, Sitka Spruce, Coast Hemlock, Canoe Cedar, Big-leaf Maple and Oregon Ash. All the subordinate species are derived from the north, that is, they have their greatest development in the great forests of the Pacific Northwest. East of the Redwood Belt is the Tan Oak Belt consisting of the Tan Oak (Fig. 24), Black Oak (Fig. 25), Maul Oak, Oregon Oak, Madroña (Fig. 26) and Douglas Fir. Tan Oak and Madroña also occur in association with the Redwood. The high inner North Coast Ranges with their forests of Yellow Pine, Sugar Pine, Incense Cedar, White Fir, and Sierra Juniper simulate on a small scale the timber belt of the Sierra Nevada. The foothills are usually thinly timbered with Blue Oak (Fig. 31) and Interior Live Oak (Fig. 30).

The beautiful and charming Coast Range valleys of Napa, Sonoma, Santa Rosa, Berryessa, Scott, Ukiah and Little Lake have characteristic silvical features in the scattered groves of Valley Oak and of Live Oak which adorn their plain-like floors.

3. South Coast Ranges.

The South Coast Ranges, from San Francisco Bay south to the north boundary of Santa Barbara County, is a land almost destitute of real forest save for the narrow tongue of the Redwood Belt protruding south along the coast in the Santa Cruz and Santa Lucia mountains and saving also scattered patches of Yellow Pine on the summits of the Santa Lucia, Gabilan, and Mt. Hamilton ranges. Otherwise the tree growth on the rolling hills and valley levels consists of thin or scattered groves of Coast Live Oak (Fig. 34), the most abundant and widely distributed tree in this region, Valley Oak and Blue Oak, or occasionally Digger Pine. Leagues and leagues of hills in this area are quite treeless since the province as a whole is naturally semi-arid.

Silvically this province is remarkable for the number of species inhabiting the coast line which have a local or exceedingly restricted distribution. The singular coast species are the Monterey Pine, Bishop Pine (Fig. 11), Monterey Cypress (Fig. 20) and Gowen Cypress.

4. Sacramento and San Joaquin Valleys.

The Sacramento and San Joaquin valleys, often collectively termed the Great Valley, present for the most part vast areas of treeless plains. The region is naturally semi-arid in the relation of climate and vegetation. The arboreal growth is wholly confined to river banks or bottoms, river benches or moist deltas or alluvial lands. Valley Oak is everywhere the most characteristic growth on the fertile loams (Fig. 28). It is well nigh the only widely dispersed tree in the Great Valley save for the fringe of willows, Oregon Ash, White Alder and Cottonwood along stream banks or in river bottoms.

5. Southern California.

Southern California comprises the counties south of the Tehachapi Range, a region which in its natural state consists of deserts except for the narrow coast strip, which is semi-arid, and the upper slopes or summits of the mountains. The trees most characteristic of this area are desert types such as One-leaf Piñon (Fig. 9), Parry Piñon, California Fan Palm (Figs. 22 and 23), Joshua Tree, Mohave Yucca, Mesa Oak, Smoke *Tree, Mesquite,* Screw Bean, Palo Verde, Desert Ironwood and

Desert Willow; also the peculiar coast types, the Torrey Pine, Catalina Ironwood and Island Oak.

On the mountain ranges from 5,000 to 12,000 feet is found a forest flora which is an extension southward of the Sierra Nevada forest at an altitude sufficient to ensure favoring climatic conditions. The species are the characteristic Yellow Pine, Jeffrey Pine, Sugar Pine (Fig. 27), White Fir and Incense Cedar.

Southern California is weak in its forest development but is remarkably rich in species of trees. This is because it has high mountain ranges situated not far from the ocean and rising out of a low-lying desert country. There is thus brought very near together three distinct silvas, the desert silva, the high montane silva and the peculiar coast silva.

Barren Foothills and Treeless Plains.

Extensive barren foothills are the most characteristic feature of the South Coast Range country beyond the borders of the Redwood Belt, especially towards the interior, and wide stretches of treeless plains are likewise characteristic of great areas of the Sacramento and San Joaquin valleys in their original natural condition. In both the above regions the soil conditions are highly favorable for the support of heavy forests. It is because of insufficient rainfall combined with seasonal conditions that these treeless areas are naturally unforested. The winter rainfall of 10 to 20 inches is too small to support a natural forest, except in cañons, northeast slopes or moist bottoms, especially when followed by a six months' rainless season. The mortality of seedlings under natural conditions is very high or universal in the long dry summer since they cannot get their roots far enough down to avoid desiccation and tide over the first annual drought period. For this reason small patches of wood in cañons or stands of trees on protected slopes of the interior South Coast Range country extend themselves little or not at all. In aboriginal days the annual firing of the country was a matter of great importance in the discouragement of young growth since grass fires are often hot enough to kill seedlings outright. There are also other minor factors which operate in limiting extension of wooded areas. Seed may not be distributed in favorable years, heavy rains may occur during the pollination

period*, frosts may and often do ruin a seed crop†, squirrels and other animals destroy great quantities of seed, and heavy winter floods carry seeds to places not favorable for germination.

Arboreous vegetation suffers as well as herbaceous vegetation when the amount of rainfall is far below the normal,—when the rains cease in February or March or do not begin until December or January. Sometimes the "wet season" is nearly or quite rainless and at irregular periods two or three "dry years" may fall together. It is during such periods that lines of Cottonwood trees, which have extended themselves in a series of wet years out into valley washes from constant streams in the foothills, die out. It is in such years, too, that trees die about failing springs in the interior South Coast Range hills.

The observations made in reference to causes of barrenness in the South Coast Ranges apply likewise to the treeless plains of the Great Valley. While trees can be readily grown on the plains under man's care, the climatic conditions and

*The acorn crop of 1908 was remarkably heavy notwithstanding the exceptionally long "dry season." Speaking generally there was no precipitation after the end of February and the rains did not break until November. The absence of rains after March 1st had two important effects on the acorns. In the first place it was exceedingly favorable to pollination and was the main factor in the setting of a heavy crop. In the second place the excessively long and arid "dry season" caused the differences in habitat and of constitutional vigor of individual trees to react strongly upon the size and form of the acorns. The acorns were, therefore, not only abundant but extraordinarily and singularly variable.

There is a further point of interest regarding this variability. Most of our species of oak, such as the Scrub Oak, Blue Oak and Valley Oak, are made up of a number of races or strains, most of such races or strains being ordinarily rather obscure. The acorns give the best indication, perhaps, of these races or strains within a single species, although ordinarily the differences amongst the acorns in such cases are very slight. In a year like 1908, however, these usually slight differences are subject to marked emphasis.

The observations made in this note as regards the setting of a heavy crop in 1908 apply of course only to the species with annual fructification, but the effects of the long "dry season" on the biennial fruiting oaks was as marked as on those of annual fructification.

†Frosts at unfavorable times not only destroy a seed crop but may alter the whole appearance of a tree. Blue Oaks on the Nacimiento *River which* had their branchlets frost-killed about 1900 presented in *1901 an appearance similar* to feathered American Elms.

annual fires of past times limited dense growth to the river bottoms or to moist delta lands.

The only region at lower altitudes in California which supports a dense natural forest is that of the main Redwood Belt where the seasonal rainfall is about 50 inches and occasionally rises to 122 inches in some portions of the belt. This high winter rainfall, in collusion with the summer fog and the moderate temperature of slight daily and seasonal range, furnishes the conditions under which the densest forest in California has been developed, namely, the Redwood stands of Humboldt and Del Norte counties (Fig. 13).

Arboreal Islands.

The coast of California is forestrally and geographically interesting for the number of local species which grow along it. The range of all of them is discontinuous, and nearly all of the mainland species recur on one or more of the Santa Barbara Islands or on islands off the Lower California coast southward. Most of these species are conifers, most are strictly littoral and most of them occur in few and widely separated localities. Such localities when very circumscribed or well-defined geographically, or by their plant composition set off rather sharply from the surrounding flora, are here called "islands." The best and most striking example of an arboreal island is that at Monterey where the Monterey Pine, a local species and the dominant tree on the Monterey Peninsula, is confined to a very limited area about five miles square. With it there are four other conifers, Bishop Pine, Knob-cone Pine, Monterey Cypress and Gowen Cypress. Bishop Pine occurs sparingly at Monterey; it recurs on the coast eighty-five miles northward and about eighty miles southward. It is also found on Cedros Island and at one station of small area on the Lower California mainland. Knob-cone Pine is local in small quantity on the Monterey Peninsula. It is widely distributed through the Coast Ranges and Sierra Nevada but the localities are few and widely separated, and with few individuals in a locality except in the far northern part of its range. Monterey Cypress is a strictly local species not occurring elsewhere, although the Guadalupe Cypress of Guadalupe Island

is very closely allied. Gowen Cypress occurs at Monterey in dwarf form and not elsewhere except locally on the Mendocino White Plains two hundred and sixteen miles northward. This formation at Monterey is a rather remarkable island since the five conifers are confined to a small littoral area and with one exception are not found elsewhere in the immediate region.

Another "island" of Monterey Pine occurs at Pescadero on the Santa Cruz coast sixty miles northerly from Monterey. A third "island" is at San Simeon on the San Luis Obispo coast eighty miles southward. Monterey Pine does not occur elsewhere on the California mainland but is found on Santa Cruz, Santa Rosa and Guadalupe islands.

Torrey Pine is restricted to a small area about eight miles long and one and one-half miles wide on the San Diego coast at Del Mar. It occurs not elsewhere save on Santa Barbara Island. Island Oak is strictly insular, being found on Santa Catalina and Guadalupe islands. Catalina Ironwood is confined to four of the Santa Barbara Islands, Santa Catalina, San Clemente, Santa Rosa and Santa Cruz. In this connection may be noted the peculiar Santa Lucia Fir which inhabits only the Santa Lucia Mountains where it is known at about ten stations.

These peculiar local species are all littoral and all confined to a few localities of limited extent. Their present representation is very meagre in individuals. They are not increasing their area but the climatic conditions of their local habitats enable them to persist. It may certainly be assumed that they once had a more extensive distribution than at present and that geological and climatic changes have narrowed them to their present limits.

At the end of the Pliocene period there was inaugurated a tremendous series of earth movements on the California coast. Geologists are by no means agreed as to the period and duration of these oscillations but in the Tertiary and Quarternary there was at intervals land connection between the present mainland and the Santa Barbara Islands. A moister climate in the Pliocene or Pleistocene periods would permit the existence of a great forest along the California coast and its extension southwards over a large land area which now rests beneath the Pacific Ocean save for the emersed peaks of the Santa Barbara Islands. *Subsidence of the mo*untainous South Coast Range area left

only vestiges of this forest on the emersed peaks or islands. Between these islands the tides flowed through the waterways (Pacheco Pass, Panoche Pass, Warthan Pass, etc.), connecting the ocean and the inland sea of the Great Valley*. The final uplift of the Coast Ranges, with the species following the receding shore downwards, accompanied by changes and diversification in climatic conditions would account for the persistence and isolation of the present arboreal islands of Monterey Pine, Monterey Cypress and other species along the California coast line. Subsidence and uplift would also explain the presence of species on some of the Santa Barbara Islands and not on others by reason of the differences of altitude among the islands.

The arboreal islands along the coast are, then, here taken to be remnants of a great Pleistocene forest. In support of such a proposition it may be indicated that the species under consideration are of few stations with few individuals, that they are living naturally within very narrow topographic and climatic limits, that they are barely holding their own in their present habitats and that evidence is at hand that the term of life of two of them, Monterey Pine and Monterey Cypress, becomes much abbreviated in the dry California interior even when living under horticultural conditions. There is also geological evidence that the former species had at one time a greater range than at present, since fossil cones have been found at Mussel Rock near San Francisco and at Preston Point on the north coast.

Big Tree may in a sense be said to form arboreal islands in the northerly parts of its range. Such groves as North, Calaveras, Stanislaus, Tuolumne, Merced, Mariposa, Fresno and Dinkey groves are isolated remnants where the favoring physical conditions made the persistence of the species locally possible. In the southern part of its range the localities are more numerous and less sharply defined.

The "Klamath Mountains."

The "Klamath Mountains" is a designation used by Diller† for a high-montane area in northwestern California and south-

*Anderson, Proc. Cal. Acad. ser. 4, vol. 3 p. 6 (1908).

†Bull. U. S. Geol. Sur. no. 196. For calling my attention to this paper I am indebted to my friend Prof. Geo. D. Louderback of the Department of Geology, University of California.

western Oregon which includes a number of mountain chains well known under the following names: Siskiyou, Scott, Salmon, Bully Choop and Yollo Bolly. This area has as its southwestern boundary the Trinity and South Fork Trinity rivers; it extends north to Rogue River, Oregon, and east to Yreka, Sisson, Redding and the upper limits of the foothills on the west side of the upper Sacramento valley. This area is described as independent, topographically and geologically, of the adjacent Coast Ranges, both in California and Oregon. The rocks are older and harder than those of the Coast Ranges and similar to those of the Sierra Nevada. The periods of uplift and subsidence as understood by Diller are described in the paper referred to above and are given in detail from the close of the Eocene down to the present epoch. During the Miocene and certainly in the Cretaceous the Coast Ranges were submerged and the "Klamath Mountains" rose out of the sea or were bordered by its estuaries. The downward movement of 1500 feet of the whole coast of northern California and southern Oregon as late as the Pleistocene is, perhaps, the oscillation of greatest interest in connection with the phenomena of plant distribution in the area under consideration. There are not as yet sufficient data available to correlate historically the geology of the region and the plant distribution. While climate must have been of first importance in determining the character of the vegetation and its distribution, of course climatic factors might have moved closely along with geological changes. In any event the geological history of the "Klamath Mountains" and their limits as defined by Diller, and the main features of the local plant distribution when brought into one view give rise at once to many interesting suggestions. The area is noteworthy in particular for the number of species which are either peculiar to the region or do not extend into the contiguous Coast Ranges. These species as a whole if plotted on a map would duplicate very closely the area defined by Diller as the "Klamath Mountains." The most noteworthy of these species is the Weeping Spruce (Picea breweriana Wats.), strictly peculiar to the "Klamath Mountains," which is found at scattered localities throughout the central portion of the area (Siskiyous and Marble Mountain), extends north to the high mountains south of Rogue River, south to the Salmon Mountains and perhaps to the neigh-

borhood of the Trinity Mountains (where it has been reported to exist). Deer Oak (Quercus sadleriana R. Br. Campst.) is also strictly peculiar to the "Klamath Mountains." It occurs in great abundance from Trinity Summit to the Siskiyous and northward in adjacent Oregon. Further exploration of the little-known South Fork Mountain and Yollo Bolly country may reveal it in that region. Foxtail Pine (Pinus balfouriana Jeffrey) occurs in the Scott and Yollo Bolly mountains, and is reported on Marble Mt. It does not occur in the contiguous regions nor elsewhere save in the high southern Sierra Nevada. Aspen occurs in the Trinity Mountains but not in the area contiguous to the Klamath area. Mountain Hemlock (Tsuga mertensiana Sarg.) occurs on the high peaks but not in the Coast Ranges of California or Oregon. Brewer Oak (Quercus garryana Hook. var. breweri Jepson) is local in the "Klamath Mountains," occurring on the summits of the Scott, Marble and Siskiyou mountains. A related form (Var. semota Jepson) occurs in the southern Sierra Nevada. Rhamnus occidentalis Howell occurs only in this region so far as known to the writer*.

A Historical Sketch of Sequoia.

The genus Sequoia is represented by two living species. Sequoia gigantea Dec. (Big Tree) and Sequoia sempervirens Endl. (Redwood), confined respectively to the Sierra Nevada and Coast Ranges of California. The number of extinct species is considerable, probably about 16. As many as 40 species have been described but some of these have been reduced and others are evidently referable to nearly allied extinct genera. The material as a whole is, however, very fragmentary and there is in consequence more or less uncertainty in regard to it.

Sequoia makes its first appearance in the Lower Cretaceous where it is frequently found. It is also frequent in the strata of the Upper Cretaceous and Miocene, being widely distributed over North America, Europe and Asia. The

*There are many herbaceous plants local to the area such as: Lewisia cotyledon Robinson, Lewisia oppositifolia Robinson, Claytonia bulbifera Gray, Thermopsis robusta Howell, Lupinus mucronulatus Howell, Erigeron confinis Howell, Senecio subvestitus Howell. This list will, doubtless, receive many accessions.

genus is well represented in the Lower and Upper Cretaceous and Miocene of Spitzbergen and especially of Greenland where it had the company of other conifers and of broad-leaved trees. Between Greenland with its fossil species and California with its living species many intermediate fossil stations have been discovered, as at the mouth of the Mackenzie River, in Alaska, Montana, Oregon, and California. Two of the sixteen extinct species have thus far been revealed by exploration in California.

Sequoia langsdorfii Heer has been found at Hyampum in Miocene beds*; it also occurs in the Miocene of the John Day Basin in Oregon (Bridge Creek, Clarnos Ferry, Lone Rock, Van Horn Ranch) and in Yellowstone Park. This species had a wide distribution both in space and time, extending from western Europe to Manchuria, Greenland, and North America and occurring from the Cretaceous to the Pliocene, being perhaps most abundant in the Miocene. Of all extinct species it is the one most nearly allied to Sequoia sempervirens. The second species is Sequoia angustifolia Lesqx. Material from Hyampum, Hay Fork, and Corral Hollow (San Joaquin County) have been referred to this species. Stations have also been determined in the John Day Basin in Oregon and in Idaho. The original material came from Elko, Nevada.

Sequoia heeri Lesqx. is known from Bridge Creek, Grant County, Oregon, and Sage Creek, Montana. About eight other valid species have been determined as occurring in North America.

The two living species are not known as fossils preceding recent Quaternary and must for the present be regarded as remnants and as the direct descendants of a great group of Miocene taxodiaceous species. The most important factors which caused the geographic segregation of the two living species on either side of the great central basin of California must have been climatic. They are even now living in essentially different climates. Sequoia gigantea inhabits a region of long mostly rainless summers with continual warm sunshine, of cold winters with moderate rainfall, with snow several feet deep and with a temperature of high daily and

*Knowlton in U. S. Geol. Sur. Bull. no. 196, p. 43.

annual range, often in winter reaching zero or below. Sequoia sempervirens inhabits a region of high winter rainfall, nearly rainless but exceedingly foggy summers, and moderate temperature with slight daily and annual range.

The Miocene forest of the Sierra Nevada doubtless contained more species of Sequoia than now. Sequoia species may possibly have been the dominant trees in that forest just as Sequoia sempervirens is today the dominant tree in the Redwood Belt. Still it must be pointed out that Pinaceae are ancestrally older than Taxodiaceae which include the Sequoias, and that the representation of Pines, Spruces, Hemlocks and Firs in the Sierra Nevada Miocene forest was probably strong in individuals as well as in species.

Native Trees in Relation to Periodic Fires.

For unnumbered centuries the mountain and valley country of California has been subject to the influence of grass, brush and forest fires. These fires in aboriginal times were periodically set by the native tribes for the purpose of keeping open their trading, hunting or harvesting trails, for driving game or in the practice of a rude agriculture. Wild fires still occur irregularly or sporadically, being set by the careless or the ignorant, by the criminally minded, or by lightning. But even if there be at some future time full control of wild fires, the lower as well as the higher country will show for centuries the effects of long-continued fire ravage. Both the forest as a whole and the individual trees which compose it have in certain features a distinct relation to centuries-old fire conditions.

The persistence of the Sierra Nevada timber belt and the Redwood Belt in spite of thousands of years of firing may be explained by several considerations. The Sierra Nevada forest as to the main timber belt lies in a region where the annual rainfall is 30 to 50 inches and where there is more or less summer precipitation. Over considerable areas the forest is a thin one, it is rarely very dense and is everywhere remarkably free from underbrush or low growth. Such climatic and forestral features are factors of prime importance in lessening fire damage. Indeed the main forestral features, i. e., density, reproductive power and dominance of types are in great part expressions of the periodic fire status. While

coniferae are very susceptible to fire on account of their resinous woods, the dominant species in the Sierra Nevada are remarkably well protected by their thick bark. Yellow Pine bark and Sugar Pine bark are 1 to 5 inches thick; Incense Cedar bark is 1 to 3 inches thick and ignites very slowly. The thickness and fire-resistant character of the protective bark of Big Tree which is ¼ to 2 feet thick has been, in connection with the non-resinous wood, an important factor in assuring a great longevity to these trees. Certain trees on the other hand are very susceptible to fire. Tamrac Pine has very thin bark and fires cause extensive damage in stands of this species. White Fir and Red Fir are well protected by thick trunk bark in the case of adult trees, but young trees suffer heavily in a forest fire.

The preservation of the Redwood Belt is to be explained by similar considerations. The Redwood forest is much denser than the Sierra Nevada forest and has a heavier undergrowth of shrubs and vines, but is comparatively more fire-resistant since it lies in an area of high winter rainfall (35 to 50 inches) and of summer fogs. The tops of the Redwoods mechanically collect the fog moisture and through dripping from the trees and the exclusion of sun by the fog and by the forest canopy, the floor of the forest is maintained in a comparatively moist condition through the dry season. The individual Redwood tree is fire-resistant because protected by a thick non-inflammable bark (3 to 12 inches thick) covering a non-resinous wood as in the case of the Big Tree. The Redwood forest is, therefore, more fire-resistant than the Sierra Nevada forest because of climatic factors and because this highly fire-resistant type of tree is far and away the dominant tree in the Redwood forest. The Redwood has also an added advantage in its power of vegetative reproduction or stump-sprouting.

Under the influence of repeated fires over the State the forest was sometimes seriously thinned out (as in portions of the Sierra Nevada belt), often restricted to narrower limits, and often on its lower borders went over into or was replaced by chaparral, although all chaparral does not represent one-time forest areas. Forest area gone over into chaparral indicates a change in conditions initiated by fire. The chaparral

area is drier, the run-off is greater and the soil in consequence thinner and poorer. While the chaparral area is thus no longer forest, some of the forest species may persist in the chaparral in shrub form. These shrubs represent modifications of the types in the forest, their characteristics being for the most part the result of the change in conditions initiated by fire. Trees of the forest type are represented in the chaparral by nearly allied shrub forms as follows:

Forest Form.	Chaparral Form.
Oregon Oak.	Brewer Oak (Var. breweri).
Interior Live Oak.	Scrub Live Oak (Var. frutescens).
Coast Live Oak.	Scrub Live Oak (Var. frutescens).
Tan Oak.	Scrub Tan Oak (Var. echinoides).
California Laurel.	Chaparral Laurel.
Buckeye.	Scrub Buckeye.

It must be noted, however, that repeated annual fires favor in certain cases or under certain conditions the development of large individual trees. If the debris or undergrowth of one year's accumulation be burned every year, adult trees are little injured. If, however, fires be prevented until after five or ten years' accumulation of forest litter and shrubs, then the periodic fire will injure more severely or even consume large trees. In proof of this theory note the large individual coniferous trees in the Sierra Nevada for which some credit must be given to the native tribes as foresters. Large Black Oak trees, also, often develop in chaparral under repeated firing and at the expense of a dense forest.

Fire-type Pines.

The cones in an ordinary type of pine like the Yellow Pine or Sugar Pine after opening and shedding their seed in the early autumn or early winter, shortly fall to the ground. The behavior of some other of our pines is in this particular very different. In the Knob-cone Pine the cones persist for very lengthened periods, 15 to 25 years or more, and they may not open during that period except through the heat of a forest fire, or occasionally and partially during successive days of great heat in summer. In case of destruction of a Knob-cone Pine forest by fire the area is thus resown with its own seed and by virtue of this peculiarity of its cones it has an advantage over other species in its struggle for possession of its favored territory. This is called a fire-type pine,

which is a type remarkably adapted to fire-stricken country. The seeds are sown at the most advantageous time, they germinate a high percentage in the ashy soil and as a result young stands of Knob-cone Pine are often exceedingly dense and uniform.

Bishop Pine is likewise a fire-type pine (Fig. 11). Its cones persist in a manner similar to those of the Knob-cone Pine but do not remain closed so long. Its young stands of saplings are very dense, pure and even. Groves of various ages, each area showing great uniformity, may be studied to advantage about Inverness.

Monterey Pine is not exactly a fire-type pine since its cones do not remain closed indefinitely but they do open tardily. It may be noted in this connection that Digger Pine cones open tardily, 1 to 8 months after the second autumn, and that the cones may persist as long as eight years. Beach Pine on the Mendocino "White Plains" has persistent cones which remain closed for two or three years after the second autumn. McNab Cypress is somewhat similar to the Beach Pine, its cones often remaining closed for one or two years after the second autumn.

The number of years which the cones of fire-type pines persist on the tree is not easy to determine definitely. The figures which have been printed in the books appear to rest on the natural assumption that only one circle of cones is produced on a given shoot in a season, but such is not the case. Bishop Pine produces 1 to 5 distinct whorls of cones on the season's shoot; Knob-cone Pine produces 1 to 3 whorls and Monterey Pine 1 to 3 whorls. Even Digger Pine occasionally produces 2 whorls of cones on a season's shoot.

Second-growth Circles.

Regeneration of the individual tree frequently occurs by stump-sprouting, a habit characteristic of a considerable number of our species. Speaking generally conifers do not stump-sprout; the felling of a pine or fir, for example, abruptly ends the life history of the individual. One notable exception is the Redwood, which stump-sprouts very freely when cut down, fire-killed or overthrown in old age. Vigorous unmutilated trees in virgin stands may also generate sprouts. These

W. L. J. photo.

Fig. 10. FOXTAIL PINE (*Pinus balfouriana* Jeffrey). Trees on granite cliffs above Little Claire Lake, Sawtooth Range, southern Sierra Nevada, altitude 11,000 feet. See pages 18 and 60.

W. L. J. photo.

Fig. 11. BISHOP PINE (*Pinus muricata* Don). Trees with flattened crowns which long ago reached normal height. The roughening of the branches as shown in the engraving is caused by the circles of cones which persist 15 to 25 years. (Road to Pt. Reyes Light in a wind-gap of the hills.) See pages 32 and 73.

Fig. 12. REDWOOD (*Sequoia sempervirens* Endl.). Characteristic grove in Sonoma County; the trunks with scattered brackets of foliage. See pages 19, 30 and 106.

A. W. Ericson photo.

Fig. 13. REDWOOD (*Sequoia sempervirens* Endl.). Virgin stand, Humboldt County, scaling 300,000 feet B. M. to the acre. Characteristic dense undergrowth of Woodwardia, and of Salal, Huckleberry, Raspberry and other shrubs. See pages 19, 30 and 106.

Fig. 14. Redwood (*Sequoia sempervirens* Endl.). "Redwood Circle" to right of centre, the trees surrounding an old stump. Characteristic "cull trees" on logged areas along the Russian River (left side of picture). See pages 19, 33 and 106.

A. W. Ericson photo

Fig. 15. REDWOOD (*Sequoia sempervirens* Endl.). Making the "undercut", which determines direction of fall, on a tree 16 feet in diameter. (Humboldt woods.) See page 108.

A. W. Ericson photo.

Fig. 16. Redwood (*Sequoia sempervirens* Endl.). Felled tree, showing the fissured bark, the narrow band

A. W. Ericson photo

Fig. 17. Redwood (*Sequoia sempervirens* Endl.). Logging in the Vance woods near Eureka; butt log in foreground 17 x 19 feet, from a tree which measured 150 feet to first limb. See page 108.

A W Ericson photo

Fig. 18. Redwood (*Sequoia sempervirens* Endl.). Sawing a log into 4-foot lengths which are split up into "shingle blocks". (Humboldt woods.) See page 108.

L. E. Hunt photo.

Fig. 19. REDWOOD (*Sequoia sempervirens* Endl.). Hillslope in central Mendocino one year after burning. The burning of the "tops" and brush was preliminary to the removal of the mill logs; the down timber was abandoned as waste. See page 32.

O. V. Lange photo.

Fig. 20. MONTEREY CYPRESS (*Cupressus macrocarpa* Hartw.). Cultivated grove on the grounds of the University of California. Trees 60 to 80 feet high, trunk diameter 3½ to 4 feet; age about 32 years. See page 118.

G. K. Gilbert photo.

Fig. 21. Coast Live Oak (*Quercus agrifolia* Neé.) Wind-controlled clumps on rock outcroppings on the ridge south of Redwood Cañon (Muir Woods), Marin County. See page 168.

sprouts grow into saplings and poles, compete with each other like distinct individuals, the strongest survive and we finally have a circle of trees about the parent stump. Inasmuch as the stumps are usually very large the circles about them are correspondingly large. The trees of these second-growth circles are sometimes felled, whereupon a new and still larger circle of trees will arise in a similar manner outside the first circle. Regeneration in the primitive Redwood forest has taken place in the manner above described for untold centuries. There are at the present time evidences of circles which began their history 500 to 1300 years ago. Probably about 80 per cent. of the adult Redwood stand consists of trees which originated from stump sprouts and not from seed. The regenerative power of the Redwood is so great that it will under natural conditions maintain possession of its area against all competition.

No other tree of the coniferous class in California stump-sprouts except the Western Yew and the California Nutmeg. The former stump-sprouts rather feebly, the latter rather vigorously. When the foliage is killed by a not too intense forest fire the California Nutmeg shows considerable vigor by sprouting very freely along the main trunk and branches.

Douglas Fir, like other species of true Pinaceae, does not stump-sprout. Very rarely one sees stumps in the forest which have covered over the wood with a complete callus as shown in Fig. 29. Such stumps have been observed by the writer in Mendocino, Del Norte and Siskiyou counties. The cause of this phenomenon is due, undoubtedly, to natural root grafting. White Fir (Abies concolor Lindl. & Gord.) has been observed to produce a similar although feeble growth. A small callus was observed on a stump of this species near Lake Merced above Yosemite Valley. The same explanation as in the case of Douglas Fir seemed reasonable.

Stump-sprouting amongst broad-leaved trees is as well-nigh universal as it is exceptional amongst conifers. The power, to be sure, differs markedly with age and in different species. The older the tree the less likely is stump-sprouting to take place. The power also varies in the same genus, as in the case of the oaks. The power to stump-sprout declines in oaks of the white oak class with age or even disappears; in oaks

of the black oak class it persists more or less into extreme age. Live Oaks, Maul Oak, and California Black Oak (species of the black oak class) stump-sprout vigorously. In some white oak species the power fails in the adult tree when the trunk is cut off close to the ground, as in the Valley Oak and Blue Oak. Increasing the height of the stump in these species, especially if the cuts be made just above the first arms of the trunk, increases correspondingly the chances of the tree's survival by sprouting.

The greatest vitality in regeneration of all members of the oak family is shown by the Tan Oak. Numerous large cone-shaped latent buds are formed at the base of the trunk in most trees. Mutilation by felling stimulates these buds into activity and many sprouts develop about the stump. The number of sprouts is very variable, commonly about 10 to 50, sometimes several hundred, and as many as 1300 have been counted by the writer. Competition for light causes, of course, a heavy mortality in these sprouts since adult circles usually contain only 3 to 8 trees. Circles of this kind, the trees almost perfectly spaced and 30 to 70 or more years old, are frequently found in the Mendocino and Humboldt woods.

Madroña stump-sprouts very freely. Since the trunk in this species commonly flares at the ground so as to form a more or less table-like base, the circle of new-growth poles or trees is commonly larger, that is of greater diameter, than in other broad-leaved trees, but Madroña circles are rarely as perfect as Tan Oak circles.

Another species which stump-sprouts is Mountain Dogwood. In connection herewith may be noted an interesting case. A tree, the foliage destroyed in a quick forest fire, was stimulated into flowering in the fall. The tree also flowered again in the second fall (Carl Purdy).

Other trees which stump-sprout are the following: California Walnut, all of the willows, Catalina Ironwood, Oregon Ash and Blue Elderberry. Mature White Alder does not stump-sprout when felled or in any event probably regenerates but feebly.

Different Forms of Leaves.

Leaves differing in morphological position, in shape, size *and* indentation of margin, or in other particulars are often

found on the same tree. Differences in morphological position are of fundamental importance and are usually accompanied by differences in shape and size. Such leaves are said to be dimorphic. The true pines have dimorphic leaves. In this genus the primary leaves are thin and scale-like, the secondary leaves or needles standing in their axils and with their bases enveloped by a "boot" consisting of scale-like leaves.

Dimorphic leaves are found in the Redwood. The ordinary leaves are linear, ½ to 1 inch long and 1 to 1¼ lines wide; they spread from the stem in two opposite rows, forming a flat spray (Fig. 66). In some adult trees the foliage in the very top of the crown consists exclusively of short-linear acuminate leaves 3 to 5 lines long and growing all around the stem (Fig. 67). These two foliage types do pass over into each other but the types are well marked and peculiar to different portions of the crown.

Two different shapes of leaves, perhaps well enough defined to be called dimorphic, in a very broad sense, grow on the Valley Oak: First, the ordinary foliage leaves which are pinnately cleft or lobed about to the middle, and, second, the leaves of the sterile shoots which are narrower and with deeper and broader sinuses. There is however no sharp line of demarcation between these two forms.

Of all our native trees Catalina Ironwood is most remarkable for dimorphic foliage. Some trees produce in the main, or perhaps exclusively, simple leaves and others, conversely, produce pinnately compound leaves. Particular trees may however bear quite generally both kinds of leaves.

Differences in shape, size and indentation may here be referred to briefly under the convenient heading of leaf variability. Nearly all of the oaks may be used to illustrate leaf variability. Maul Oak is almost characterized by its variability in foliage, both in size and character of margin. While the leaves in the crown of an adult Maul Oak are mainly entire, entire leaves and toothed leaves characteristically occur on the same branchlets. Extreme toothing or dentation in this species may be produced artificially. For example, a vigorous two-foot tree which was felled, shortly covered over the stump with a thrifty bush-like clump of new growth all the leaves of which were very numerous and very small (much smaller than the leaves of the original

tree), very uniform in size, and very prickly (Fig. 91g). Spininess in this instance is accounted for by an excess of growth force, an explanation which covers similar cases in the Blue Oak, Live Oak and other species.

Variability of leaf form in the Blue Oak is very pronounced, either on the same tree or different trees. One tree will be characterized by small entire oblong leaves, another by large entire or sparingly toothed oblong or ovate leaves; others by oblong, elliptic, obovate or roundish leaves, entire, few- or many-toothed, or lobed (Figs. 88 and 89). Scrub Oak far surpasses Blue Oak in eccentricity of leaf outline; typically with oblong unequally toothed leaves it runs off into small entire leaves, very spiny leaves, or pinnately lobed leaves—all this accompanied by a corresponding range or fluctuation in size. In such cases it may be difficult from a mere fragment of a specimen or even from ample material to determine the species. The collection, therefore, of a long series of specimens from a favorable individual, especially one which is stump-sprouting, is exceedingly helpful in determining the limits of leaf variability in a given species.

Food Products of the Native Trees.

The subject of the food resources of the native trees has at this time mainly a historical or anthropological interest. Very few of our native species are looked upon as having any economic importance in these days of the white man. In other days—days past when the native tribes owned all California—the food products of forest and wood were of such economic value that the main existence of a tribe not infrequently depended upon the annual harvest from the trees.

The oaks in this particular were easily of first importance on account of the food value of the acorns, their heavy crop and their accessibility. Eleven species of white oaks grow within our borders and these white oaks were first in favor because they bear acorns less bitter than those of the black oaks. Of the white oaks no other species is so widely distributed over valley floors and bears acorns so abundantly as the Valley Oak. Indian village sites were usually situated in or near groves of these trees and particular groves and even particular trees were the special property of certain families or individuals. The

acorns are large but long and narrow, the kernel very sweet and palatable when roasted. As was probably the case with all native tribes the acorns were shelled, the kernels dried and the winter supply put away in storage baskets or willow cribs. The mode of preparation varied. Usually the kernels were put into a mortar, or on the surface of a flat rock as shown in Fig. 32, and ground with a pestle into flour. The flour was immediately made into soup or into a heavy black bread for the day's consumption. Blue Oak—which belongs to the white oak class—also furnished a considerable food supply.

The Live Oaks and the California Black Oak belong to the black oak class; their acorns were similarly ground into flour but the flour was usually leeched to rid it of the bitter principle peculiar to the black oaks. Tan Oak, like the black oaks, has a bitter acorn, but the tree occurs in such abundance in northwestern California that its acorn crop was extensively used by the lower Klamath and Eel river tribes. Even at this date Tan Oak is a food resource of Trinity River and New River Indians and white men may still see Indian women leeching flour in the sands of those rivers.

All of the pines with large nuts furnished food to the Indians, the most important species being the Digger Pine which is distributed in the foothills around the oval of the Great Valley and the One-leaf Piñon which inhabits the desert ranges, the desert slopes of the Sierra Nevada, or the desert slopes of the mountains of Southern California. The nuts of the former are larger than but not so palatable as those of the One-leaf Piñon which are still gathered in large quantities by the desert Indians and sold in the white men's markets throughout California under the name of piñon nuts. The harvesting of the nuts is a picturesque operation. The men strike the cones from the trees with poles; the women gather the cones into heaps where they are burned sufficiently to open, after which the nuts are shelled out. Other pines which may properly be called nut pines are the Parry Piñon (not so esteemed as the One-leaf Piñon), the Torrey Pine and the Big-cone Pine. All of the above pines are of the foothills or middle altitudes of the mountains.

Crops of nuts from pines at higher altitudes were also harvested. When it came autumn the tribe went on a long journey to the high mountains above their valleys where the Sugar

Pines grow on the ridges, and celebrated their sylvan journeys by tree-climbing contests amongst the men. The large cones of the Sugar Pine carry a goodly supply of small but very sweet-kerneled seeds and were correspondingly regarded. Yellow Pine, Silver Pine and White-bark Pine were other mountain pines whose seeds are large enough for Indian collection.

In addition to acorns and nuts a number of other trees furnished a variety of foods. The large seeds of the Buckeye were ground into flour which was washed to rid it of its powerful astringency. The berries of the Blue Elderberry and Madroña were used as food. A harvest, exceedingly important to the desert tribes, is found in the pods of the Honey Mesquite, Palo Verde, Screw-bean and Desert Ironwood, their importance being about in the order given.

The nut-like drupe of the California Nutmeg contains a rich oily kernel esteemed by the Indians. These were eaten, not raw but roasted, and not in quantity but a little at a time as one might use olives as a condiment.

Local Tree Distribution and the Indian Tribes.

In some cases it is evident that native species of trees do not follow the general laws of tree distribution in California, but are found in peculiar stations or habitats. These stations would not antecedently be expected and moreover are not geographically consistent among themselves.

California Walnut offers such a problem. The stations in central California at Walnut Creek, Walnut Grove, Wooden Valley and Gordon Valley are different in character, widely separated from each other, and removed by a great gap from the main body of the species in Southern California. This gap represents an interval of 260 miles, a stretch of territory as suitable for the growth of the walnut as Southern California, but where the species is not known to exist in a natural state. The writer solves the difficulty in this way. These northern colonies undoubtedly originated from seed derived from Southern California through the trading expeditions of the native tribes at a time that antedated by centuries the earliest local Spanish settlements. They are found in all cases about old Indian village sites and in the case of the Wooden Valley station the colony is *gradually being* exterminated by the advance of the primitive

forest which is no longer held in check by the one-time occupants of the tribal settlement.

Very fine Buckeye trees are found on Indian shell mounds about San Francisco Bay. Undoubtedly the presence of these trees is connected with the storage of Buckeye balls and their use as food by the native tribes. To account for Buckeye trees in such habitats it is not necessary to assume anything more than accidental planting since it would be remarkable if some seeding did not take place in this way.

The long inhabitation of the country by the Indians and the peculiar local distribution of the Valley Oak in the rich valleys is in some way connected. These oak orchards, of great food importance to the native tribes, indicate plainly the influence on the trees of Indian occupancy of the country. The extent and nature of the relation of Indian tribal culture and the habit of the oaks cannot yet, if ever, be completely defined, although it is clear that the singular spacing of the trees is a result of the annual firing of the country—an aboriginal practice of which there is ample historical evidence.

The localities of One-leaf Piñon are some of them isolated, peculiar, and scarcely related to the distribution of the species as a whole. Since Piñon nuts were an important Indian food and were an article of barter on Indian trade routes far beyond the natural range of the species it may be possible to explain some outlying stations as due to Indian agency.

National and State Parks in California.

There are in California three national parks, Yosemite, General Grant and Sequoia. Its number of national parks is a tribute to the scenic grandeur and natural interests of its woodlands and mountains. Yosemite Park is 36 miles from north to south and averages 42 miles from east to west. It has an area of about 968,000 acres and includes the unique and incomparable mountain valleys of Yosemite and Hetch-Hetchy, the main crest of the Sierra Nevada with its peaks of Dana, Gibbs and Lyell 13,000 feet high, and the main timber belt between 4,000 and 7,000 feet with the Tuolumne, Merced and Mariposa Groves of Big Trees. The "Big Tree Grant," two miles square and containing the Mariposa Grove, has been made an integral part of the Yosemite National Park and is, as formerly, administered as part of it.

The General Grant National Park is two miles square and has an area of 2,560 acres. It is situated on the boundary of Fresno and Tulare counties and contains some fine groups of Big Trees.

The Sequoia National Park lies chiefly in the basin of the Kaweah River. Its length from north to south is 24 miles and its width is 12 miles except directly in the middle where it is 6 miles. It has an area of 161,280 acres. This park contains nine forests or groves of Big Trees: North Kaweah Forest, Giant Forest, Cliff Creek Grove, Harmon Meadow Grove, Atwell Grove, Lake Cañon Grove, Mule Gulch Grove, Homer Peak Forest, South Kaweah Forest. The Giant Forest on the Marble Fork is especially remarkable for the number and size of Big Trees, the beauty of the associated conifers, and the imposing character of the Marble Fork plateau and its surrounding gorges and lofty peaks.

National monuments may be set aside under the terms of an act of Congress for the preservation of objects of scientific or historical value. The most important difference between a national park and a national monument is that a national park is specifically created by act of Congress. A national monument on the contrary is established by executive action of the President of the United States and may be disestablished in the same way.

The national monuments in California number four. In the view of utility they are practically national parks, although legally classified as national monuments. The four monuments are: The Pinnacles in Monterey County, 2,080 acres; Lassen Peak in Shasta County, 1,280 acres; Cinder Cone in Lassen County, 5,120 acres; and Muir Woods in Marin County, 295 acres. Of these the one of most immediate popular utility is Muir Woods which was the gift of a public-spirited citizen, Mr. William Kent, to the nation in 1908. It includes Redwood Cañon on the south side of Mt. Tamalpais with its grove of Redwood and is of especial value on account of its nearness to great centers of population on the shores of San Francisco Bay.

The Calaveras Grove of Big Trees is neither a national park nor a national monument. By act of Congress in 1909 provision has been made whereby the government can acquire this privately *owned grove by* giving in exchange land of equal value else-

where. After the terms have been decided on and the exchange made the law provides that the area shall be known as the Calaveras National Forest. Thus as a result of prolonged agitation on the part of Californians the Calaveras Grove of Big Trees is now safe from threatened destruction. This grove was the first discovered and in its human associations is the most interesting historically. Travelers from all parts of the world have visited it since its discovery in 1852.

It were better, had such arrangement been possible, that this grove be made a national park rather than a national forest. A forester is properly put in charge of a forest but no typical forester should be in charge of a park. The forester's whole training, which involves the growing and lumbering of trees in the most profitable manner, unfits him for the care of a park. A forester in charge of a park cannot get away from rates of growth and the development of trees with the greatest possible log value, that is commercially perfect trees. He sees in every tree, and properly, so many feet of clear timber, so much profit or loss. It is obvious that quite other considerations should govern the care of a park where the trees are of most importance in their relation to the landscape and are to be respected according to standards of beauty and taste which are nature's own.

The State of California owns one park, the California Redwood Park. It includes the Big Basin of the Santa Cruz Mountains with an area of 3,800 acres and was purchased in 1901. It is a fine mixed woodland of Redwood, Douglas Fir, Tan Oak, Black Oak and Madroña. This and Muir Woods are the only areas of Redwood which have the protection of the State or nation for preservation in primitive condition.* The Redwood reaches its most splendid development in the northern part of its range on the Main Eel River. It is, therefore, important that a park embracing a portion of the finest stand in Humboldt County be kept in its natural state.

The parks of California will do much towards preserving for all time something of the natural wild beauty of the State which beyond the bounds of such preserves is being changed or modified or even locally destroyed by the rapid growth of

*A bill providing for the purchase of the Armstrong Redwood Grove in Sonoma County was passed by the California Legislature in 1909 but failed of executive approval.

a strenuous civilization. It is highly important that our parks be safe from industrial exploitation and that the encroachments of private companies or even municipal corporations be watchfully and vigorously resisted. The landscape as a whole is a valuable asset and should be made especially safe from spoliation within park boundaries.

Even beyond park boundaries heedless and needless marring of the scenery ought not to be permitted. Of course agriculture, manufacture and the like must inevitably modify landscapes. In some cases it is, however, quite possible to mitigate the destructive effects of civilized occupation and yet not interfere with the orderly progress of our civilization. An illustration may be given to show one way in which the original character of the landscape may in great part be preserved. The beauty of the interior and some coast valleys is very largely due to the presence of the scattered groves of the Valley or Weeping Oak. These splendid trees give the valley floors a distinction which is entirely lacking to them when the oaks are cut away to make room for orchards and gardens. It is however quite possible to offset largely the effects of this removal by using the Valley Oak on the main and cross roads as a roadside tree, particularly by planting at irregular intervals. A few owners of roadside frontage have made such plantings and there must be numerous others, permanent land-owners, who at nominal expense would be glad to help restore, where destroyed, the park-like beauty of the Californian valleys.

The parks of California, while of greatest practical utility to the general public, are also of especial interest to botanists of future generations because it is only, or at least chiefly, within their boundaries that the native trees will be preserved in a natural state. If there is, however, to be protection of fine examples of even most of the native trees in their regions of best development and especially of local species, it will be necessary to increase the number of parks. There are no mixed woodlands in the State comparable to those of the "Bald Hills" of Mendocino and Humboldt where the Madroña, Tan Oak, Maul Oak and Black Oak reach a size and grandeur quite as remarkable for the broad-leaved trees as the Sequoias for the coniferous trees. Such parks might well be made by our own *citizens for public* use. The way for this kind of service to the

community lies broad and open, for one man, Mr. William Kent, has recently shown the way by which the public may realize the highest possible benefits from primitive woodlands.

National Forests in California.

There are in California twenty national forests. Of these five lie partly within other States. Crater and Siskiyou National Forests are mainly in Oregon. Small portions of Tahoe and Inyo National Forests and over one-third of Mono National Forest are in Nevada. The areas given below are for California.

Forest.	Headquarters of Supervisor.	Area in Acres.
Angeles	Los Angeles	1,350,900
California	Willows	1,114,904
Cleveland	San Diego	2,236,178
Crater	Medford, Oreg.	58,614
Inyo	Bishop	1,458,444
Klamath	Yreka	2,094,467
Lassen	Red Bluff	1,373,043
Modoc	Alturas	1,471,817
Mono	Gardnerville, Nev.	813,789
Monterey	Salinas	514,477
Plumas	Quincy	1,407,053
San Luis	San Luis Obispo	355,990
Santa Barbara	Santa Barbara	2,027,180
Sequoia	Hot Springs	3,079,942
Shasta	Sisson	1,754,718
Sierra	Northfork	1,935,680
Siskiyou	Grants Pass, Oreg.	37,814
Stanislaus	Sonora	1,117,625
Tahoe	Nevada City	1.931,042
Trinity	Weaverville	1.834,833
Total		27,968,510

California has at the present time (April, 1909) a larger area in National Forests than any other State or Territory. Alaska stands next with 26,761,626 acres in National Forests.

Purpose of National Forests.

The establishment and development of national forests by the nation is a movement of recent growth. While this movement is one of vast importance to the people of our Commonwealth, it is only recently that there has been a marked growth of popular opinion on the relation of natural resources to the permanent welfare of the community. Growth of sentiment

on the subject of conservation as a national policy has received great strength and vivifying influence under the leadership of Gifford Pinchot, head of the United States Forest Service. To describe his forest policy is essentially to describe the policy of conservation of natural resources of which he is the ablest, most vigorous and far-seeing representative.

The National Forest policy is sharply and clearly defined. National Forests, in brief, are created for use. Their timber, grazing lands, and water are for use. All are to be made of the fullest possible use to the people of the States containing National Forests as well as to the nation. Use of these National Forest resources is indeed the watchword of the forester.

Preservation of trees and preservation of forests are often confused. Preservation of trees in a park is a first consideration because of the relations which these bear to beauty in landscape effects or to their historic or scientific interest. This is obviously not the case in a timber forest. It is a mistaken idea that the trees in a national forest are to be preserved without use. Every tree there, especially mature and over-mature timber, is destined to be or is now being cut and sold for conversion into lumber for the use of the public and to make room for new growth. The logging of trees is carried on under such methods and such safe guards that a new stand is assured or that established is protected and the forest yield eventually increased over the yield in a state of nature. This is preservation of the forest by wise use—this is rational forestry.

The grazing lands of the National Forests are likewise for the benefit of the sheep and cattle men and are subject only to such restrictions as are in themselves imperative for continuance of good grazing which is of vital interest to the development and maintenance of the live stock industry.

The waters and streams of the National Forests are also for use—for irrigation and the development of power. The water policy of the national Forest Service is also as sharply defined as any other part of its forest policy*. The waters

*See Forest Service Use Book, "Water," p. 217; also pp. 233-240 inclusive for regulations governing rights of way to carry water over *forests.*

are for use—for the irrigationist and the power engineer—but always under lease from the government, in no case to be sold outright or in perpetual lease. This matter right here is of vast significance. It is of absolutely fundamental importance to the status of the people as a whole if they would live in a commonwealth free in fact as well as in name. There is nothing which is more vital than water. Water is our first and most pressing physical need. It is necessary not only to all the functions of the human body but to all animal and plant functions as well. Water is, however, in a way so common that like daily sunshine it is disregarded.

Let us consider briefly. We have at present just so much average annual rainfall in California, so much water for each individual of our 1¾ millions population. There is absolutely no way in which this per capita amount can be increased. Grandly and somewhat light heartedly the economist or promoter talks of the not distant day when California will support a population of 15 or 50 millions. Now in just the degree that our population increases will every drop of water become more precious, for we shall not get one drop more. It is therefore the policy of the Forest Service to prevent the monopoly of water power, that is the concentration in one or few individuals of absolute ownership in perpetuity of the flowing streams in national forests. Our general rainfall is too scant to tolerate such a water monopoly. The Forest Service policy must in this particular as well be strongly upheld for the simple reason that water is a vital necessity to life and should belong to the whole people.

The object of this volume, which is to provide a descriptive botany of the native timber trees, precludes further discussion of National Forests in this place. The apology for the insertion of this section, foreign to the main purpose of the book, is a desire to make clear to the laity the difference between forests and parks, the latter being of special botanical importance in the present view as preserves for native trees.

Common Names.

The common names of California trees have been derived in the main from three sources: 1. From the Spanish language through the Spanish-Californians. Such names as Piñon, Madroña, Palo Verde, Encina and Roble are heritages

from the Spanish occupation. Whilst their meaning and application have been more or less changed and limited during the period of transplantation from Spain, they are as employed by us useful and definite, and especially valuable on account of their historical significance and musical quality.

2. From the folk, i. e. folk-names originating in California. Names of this class form the most valuable common names because they are usually definite, pointed, and full of meaning. Here belong Sugar Pine, Silver Pine, Digger Pine, Big-cone Pine, Big Tree, Redwood, Maul Oak, Blue Oak, Valley Oak or Weeping Oak, and others.

3. From imported folk-names, i. e. English folk-names of species of the Eastern United States or of Europe, applied by travelers or settlers to more or less nearly related species endemic in California. To this class belong Tamarack, Jack Pine, Bull Pine, Yellow Pine, Pin Oak, Jack Oak, Post Oak, and many others. The use of some of these is very loose and promiscuous. Quercus garryana (Oregon Oak) is for example called Post Oak by settlers in the North Coast Ranges. Quercus douglasii (Blue Oak) is also called Post Oak by ranchmen in some parts of the Sierra foothills. Post Oak is here rejected because, first, unnecessary, and second it is the proper common name of an Eastern oak. Such instances could readily be given at greater length. On the other hand certain importations have been retained. Yellow Pine (or more specifically Western Yellow Pine to distinguish it from the eastern Yellow Pine) is a name kept for Pinus ponderosa because so thoroughly established by usage that it is not open to change. While Pinus murrayana is not a Tamarack (which is a tree of the eastern United States belonging to the genus Larix), this common name has become so fixed by custom that it were hopeless to dislodge it and our species may properly and conveniently bear the appellation Tamrac Pine. "Tamrac" spelled thus reflects our pronounciation and joined with "Pine" gives us a combination which is distinctive and botanically accurate. In short the decisions here made have held in view the firmer lodgment of well-established common names and the crippling or rejection of those with least claims to place.

As to generic common names, such as oak, poplar, willow,

walnut and maple amongst the broad-leaved trees, there is no need of confusion. There is, however, common failure by laymen to distinguish amongst genera of the coniferous trees. Nurserymen in particular mix spruces, firs and hemlocks. The Pine Family proper consists of eight genera which may be distinguished by their leaves and cones. The genus Pinus (Pine) has needle-like leaves borne 2 to 5 in a boot-like sheath, in which particular it differs from all the other genera. Abies (Fir) has narrowly linear bluntish leaves which imprint a roundish smooth scar on the branch in falling; the cones are borne erect on the limb and fall to pieces on the tree. The cones of Picea (Spruce) and Tsuga (Hemlock) fall whole; Picea has usually bristly-pointed rigid leaves which, when falling, disjoint from a spreading peg-like base which persists and roughens the branchlet; Tsuga has soft bluntish leaves which when falling break away from a persistent base which is ascending and somewhat blended with the stem and not spreading. The genus Pseudotsuga is a very peculiar and definite genus; its leaves are linear and blunt, the exserted and conspicuous bracts of the cones are notched and bear a spear-like point in the notch. The cone alone, or even the bract, would distinguish these trees from any other. Yet the genus, one of comparatively modern discovery, has no distinctive common name, although various combinations of "Fir," "Spruce" and "Hemlock" with "False" or some other word have been applied to it. It is most nearly related to the Spruces perhaps and our common species Pseudotsuga taxifolia has long been called Douglas Spruce by botanists. Its bark, however, is that of a Fir and not a Spruce and as woodsmen recognize a tree first of all by its bark and as they call this tree "fir," the combination Douglas Fir finds a wide and easy acceptance. Moreover, this name has been adopted by the Pacific Coast Lumbermen's Association and the United States Forest Service and will undoubtedly prevail as the common name. In this connection it is interesting to indicate that the wood of this tree when manufactured into lumber is sold everywhere on the market under the name of "Oregon Pine."

Cedrus (Cedar) is evergreen and includes the true cedars, such as the Lebanon and Deodar Cedars; it has needle-like leaves in clusters but the cones are borne erect upon the branch and fall to pieces on the tree. All the preceding genera of the Pine

Family are evergreens. Larix (Larch) is a deciduous genus with needle-like leaves. Pseudolarix is an Asiatic genus.

The Cypress Family demands mention in relation to the name Cedar. That name in an accurate botanical sense belongs exclusively to trees of the genus Cedrus but in various combinations it gives us useful and widely used names for trees of other families, especially the Cypress Family. Names of this kind are now well established for such species of the Cypress Family as Libocedrus decurrens (Incense Cedar), Thuja plicata (Canoe Cedar) and Chamaecyparis lawsoniana (Port Orford Cedar), and are freely accepted by botanists.

The genus Sequoia has two species: Sequoia gigantea (Big Tree) and Sequoia sempervirens (Redwood). The common names are to be used as indicated. The name Redwood should be used only for the coast species (Sequoia sempervirens) and the name Big Tree only for the Sierra Nevada tree (Sequoia gigantea). Literally and scientifically it is true that Sequoia gigantea is as much a "redwood" as the other and it is so called locally by settlers. On the other hand Big Tree as a name might easily, in fact has been applied locally to Sequoia sempervirens. Precedence, best custom and widest usage decree, however, that Big Tree shall be restricted to the Sierra species and Redwood to the coast species. That Sequoia gigantea lumber is marketed as Redwood is of no moment in this connection. Commercial names give no certain clue to proper designation of species. "Alaska Pine" of the lumber yards is not botanically pine but hemlock and any woodsman would recognize the tree as such in the forest. "White Pine" lumber is manufactured from Yellow Pine logs, and thus the examples might be multiplied.

Exploration: Far Afield and Locally.

This book is one of the results of study and experiment upon a large amount of tree material gathered during a period of twenty years in all parts of California on many expeditions into the mountains, through the valleys, along the seashore and across the deserts. On botanical trips one may travel in part by rail, boat, stage and camp-wagon, but most of all and best of all on foot as is proper for a botanist. The most effective means of traversing wild or inaccessible regions is by means of riding animals with pack mules for carrying camp supplies and

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Fig. 22. CALIFORNIA FAN PALM (*Washingtonia filifera* Wendl.). Thousand Palm Cañon, the finest known grove; eight miles northeast of Indio and about four miles north of Southern Pacific railroad track. See pages 20 and 132

W. L. J. photo.

Fig. 23. California Fan Palm (*Washingtonia filifera* Wendl.). Trees in upper part of Palm Cañon, east base of Mt. San Jacinto. See pages 20 and 132.

W. C. Blasdale photo.

Fig. 24. TAN OAK (*Pasania densiflora* Oerst.). Broad-crowned tree growing in the open. (Hupa Valley.) See pages 19, 34 and 175.

Fig. 25. California Black Oak (*Quercus kelloggii* Newb.). Characteristic line of trees along a ridge in the North Coast Ranges. (Berrys to Three Creeks, Humboldt County.) See pages 19, 34 and 173.

P. E. Goddard photo.

Fig. 26. MADROÑA (*Arbutus menziesii* Pursh.). This is a portrait of the largest known individual, the "Council Madroña", situated on the southern slopes of Fox Spring ridge near the Mattole River in southwestern Humboldt. Height 75 feet, diameter of crown 99 feet, trunk diameter 8 feet at ground and 7⅓ feet at 4½ feet above ground. This remarkable tree in 1902 was in perfect health; the crown is rounded and symmetrical, the trunk faultless, without axe-scars, fire burns or disease. See pages 19, 34 and 208.

W. L. J. photo.

Fig. 27. SUGAR PINE (*Pinus lambertiana* Dougl.). Characteristic crowns, the branches of very unequal length. (Mt. San Jacinto). See pages 18 and 57.

W. L. J. photo

Fig. 28. VALLEY OAK (*Quercus lobata* Neé). Tree with the characteristic weeping sprays; usually scattered about singly on the valley floors, rarely crowding each other. (West side of the Sacramento Valley, one mile east of Vacaville.) See *pages 19, 20,* 34 and 157.

P. E. Goddard photo.

Fig. 29. Douglas Fir (*Pseudotsuga taxifolia* Britt.). Stump 2½ feet high, the top completely covered by a callus formation from the cambium layer. (Mendocino County.) Several other examples of healed-over trunks have been found by the author in Mendocino, Del Norte and Siskiyou counties. See page 33.

W. L. J. photo.

Fig. 30. INTERIOR LIVE OAK (*Quercus wislizenii* A. DC.). Characteristic scattered growth on hot interior foothills, some Blue Oak mixed with it. (Laguna Valley, Solano County.) See pages 19 and 171.

E. E. Pa1k photo.

Fig. 31. BLUE OAK (*Quercus douglasii* H. & A.). Characteristic scattered growth on the foothills east of Ukiah Valley; some young vase-shaped Valley Oak in bottoms. See pages 19 and 161.

V. K. Chesnut photo.

Fig. 32. Ylaki Indian woman grinding Valley Oak acorns into flour with a stone pestle on a flat rock; the basket, which has no bottom, prevents the meal from spreading. See page 36.

W. L. J. photo.

Fig. 33. Field Investigation of California Trees. Expedition of the author to South Fork of Salmon River, 1902. Transporting camp equipment and swim ning pack mules and riding animals across the Trinity River. See page 48.

Henri Hus photo.

Fig. 34. Coast Live Oak (*Quercus agrifolia* Neé). Grove in a cañon bottom at Berkeley. Trees 40 to 55 feet high, 1 to 3 feet in diameter, and 80 to 150 years old. Sometimes on hill slopes or in wind-gaps in the Coast Ranges trunks will trail along the ground, whence the folk-name Creeping Oak. See pages 20 and 168.

botanical equipment. Of course the botanical part of such work constitutes by no means the whole enjoyment or profit. There are all the high satisfactions which come from life in the open—the delights of the trail, the matching of one's powers or ingenuity with the elements in a storm, or with the currents and eddies of a river in flood. Even the botanist must lament with some others, hunters and fishers, trappers and mountaineers, that the wild places of our California are so rapidly being civilized and restricted.

However, there are still numerous wild bits even next door to our cities and towns. All such places afford the best of laboratories (that of nature's out of doors) for the study and observation of native trees and plants, their habits, life-history, relation to seasonal conditions, reproductive power and structural characteristics. This volume is intended for use by the amateur as a means of beginning such studies. He will naturally want first to know the names of his trees, a desire which the following pages will hope to satisfy. The beginner may well use the pictures or the index of common names to determine some of the common species, but that once done he should carefully compare a known tree with its description and thereby learn how to interpret a diagnosis and how it applies to a species. The significance of descriptive terms may be further gathered by reference to the glossary. Careful work of this sort can readily be done and must be done if one would gain any real power. Illustrations are a helpful aid but cannot be relied on solely, even were every species here figured. Species which are difficult in nature cannot be made easy by pictures, but they can be made fairly clear by carefully worded diagnoses. It has not been the aim of the author to "popularize" these pages to any marked extent. A "thoroughly popularized" botany book usually contains very little botany. Such excessively diluted botanical pabulum may momentarily tickle some palates but it can afford no proper and sustaining food to a man or woman who is really and truly alive.

Key to the Families.

GYMNOSPERMS.—NAKED-SEEDED PLANTS.

Seeds borne naked on the surface of a scale. Stamens and ovules in catkin-like clusters (no pistils and no true flowers, that is, without an abbreviated stem bearing regular whorls of floral envelopes, stamens, and pistils).

DIVISION I. **Cone-bearing Trees.** (Polycots.)

Cone-bearing trees or shrubs, all of ours evergreen. Trunk usually carried up through crown as a continuous axis. Leaves needle-like, narrowly linear, awl-like or scale-like. Seed-leaves 2 to 17.

Fruit a woody cone, containing several to many seeds.

Leaves needle-like or narrowly linear; cones large or small, their scales overlapping or imbricated, each with a minute bract concealed at base on the lower side or the bract sometimes half as long as the scale or even exserted and conspicuous; seeds 2 to each scale, bearing a thin wing.....PINE FAMILY, p. 53.

Leaves narrowly linear and 2-ranked in flat sprays, or lanceolate or awl-like and disposed all around the stem; cones small, their scales not overlapping, ending in broad flattish summits, without bracts; seeds 2 to 9 to each scale, not winged.....REDWOOD FAMILY, p. 101.

Leaves minute and scale-like, thickly clothing and concealing the ultimate branchlets; cones small; scales overlapping, or with broad flattish summits and not overlapping, without bracts; seeds 1 to several to each scale, winged or wingless.....CYPRESS FAMILY, p. 111.

Fruit berry-like or fleshy, one-seeded; leaves narrowly linear, in flat sprays; seed not winged.....YEW FAMILY, p. 125.

ANGIOSPERMS.—FLOWERING PLANTS.

Seeds borne in a closed receptacle or pod. Plants with true flowers, typically with floral envelopes (calyx and corolla) and essential organs (stamens and pistils) regularly arranged on a short axis. Stamens and pistils in the same or different flowers.

DIVISION II. **Palm Trees.** (Monocots.)

Palm or palm-like evergreen trees, the trunk simple or sparingly branched. Leaves parallel-veined, borne in a tuft at summit of stem or end of branches. Stem increasing in diameter by irregular growth, not by definite concentric layers. Flowers with the parts in 3s or 6s. Seed-leaf 1.

Leaves (in our trees) bayonet-like; flowers perfect, borne in a huge terminal panicle, not enclosed by a spathe.....LILY FAMILY, p. 129.

Leaves ample, fan-shaped; flowers unisexual, borne in large clusters enclosed by a spathe.....PALM FAMILY, p. 131.

DIVISION III. **Broad-leaved Trees.** (Dicots.)

Deciduous or evergreen trees, the trunk usually parting into branches, rarely persistent through crown as a continuous axis. Leaves broad, at least never needle-like in ours, netted-veined. Stem increasing in diameter by means of concentric layers. Parts of the flower in 5s or 4s. Seed-leaves 2.

A. Flowers in catkins, small and inconspicuous, never with corolla; stamens and pistils always in separate flowers; leaves alternate.

Staminate and pistillate flowers on different trees, both kinds in catkins; ovary superior; fruit a pod which splits open; seeds with a tuft of hairs; leaves simple; bark bitter; deciduous trees, mostly of stream banks or moist bottoms.....WILLOW FAMILY, p. 133.

Staminate and pistillate flowers on same tree; all deciduous trees except some of the oaks.

Leaves pinnately compound; staminate flowers in catkins; fruit a nut with a husk.....WALNUT FAMILY, p. 144.

Leaves simple; both kinds of flowers in catkins, the pistillate catkins maturing into a woody fruit strikingly like a cone; fruit very small, 1-seeded, not splitting open, seed-like..BIRCH FAMILY, p. 147.

Leaves simple; staminate flowers in catkins; fruit a nut, either set in an acorn cup or spiny bur.....OAK FAMILY, p. 152.

B. Flowers not in catkins; stamens and pistils frequently in the same flower.

1. Corolla when present with distinct petals (choripetalous).

Leaves alternate.

Leaves large, palmately lobed with prominent stipules; flowers minute, in ball-like clusters scattered along a pendulous thread-like axis; fruit very small, seed-like; tree of stream beds.....PLANE FAMILY, p. 179.

Leaves simple, entire, strongly aromatic; flowers in inconspicuous clusters; corolla none; stamens 9; fruit olive-like; evergreen tree.....LAUREL FAMILY, p. 182.

Leaves simple or compound; flowers (in our trees) always with both stamens and pistils; stamens 10 to many, inserted on the calyx; fruit various; wood very hard.....ROSE FAMILY, p. 185.

Leaves (in our trees) compound; flowers mostly butterfly-like (i. e. with same plan as a Sweet-Pea); stamens 10; fruit a 2-valved pod (legume).....PEA FAMILY, p. 190.

Leaves opposite or none.

Leaves palmately compound; flowers in a showy cylindric cluster; stamens 3 to 10; fruit a large 3-valved hanging pod; deciduous tree.....BUCKEYE FAMILY, p. 195.

Leaves mostly simple and palmately lobed (one species pinnately compound); flowers small, mostly in hanging clusters; stamens 3 to 10; fruit a 2-winged pod (double samara)..MAPLE FAMILY, p. 199.

Leaves reduced to scales or prickles; spiny columnar or globose trees or shrubs; stamens numerous; flowers showy; fruit fleshy.... .....CACTUS FAMILY, p. 205.

Leaves simple; flowers small, in clusters, the clusters with showy petal-like white bracts; petals and stamens 4; fruit a tiny drupe.....DOGWOOD FAMILY, p. 206.

2. Corolla when present with united petals (sympetalous).

Leaves alternate, simple; our tree with showy clusters of white flowers, the corollas like "Lily of the Valley"; stamens 5 or 10; fruit berry-like.....HEATH FAMILY, p. 207.

Leaves in ours opposite and pinnately compound; flowers minute; stamens (2) and pistils in separate flowers; fruit a winged pod (samara).... .....ASH FAMILY, p. 210.

Leaves simple, narrow and long; corolla showy, 2-lipped; stamens 4; fruit a dehiscent pod; seeds winged; slender willow-like tree of the Colorado Desert.....BIGNONIA FAMILY, p. 214.

Leaves in our tree compound and opposite; flowers small, in a large flat-topped cluster; corolla regular; stamens 5; fruit a berry..... .....HONEYSUCKLE FAMILY, p. 215.

Fig. 35. BIG TREE cone. nat. size.

Division I.
CONIFEROUS TREES. (POLYCOTS).

Trees or shrubs, ours evergreen with linear, awl-like, or scale-like leaves. Wood resinous, the trunk usually persisting through the crown as a single axis, increasing in diameter by an annual layer of wood inside the bark. Stamens and ovules borne in clusters, generally on different branches, sometimes on different trees. Stamens generally spirally arranged in a catkin-like cluster which falls after maturity. Pollen abundant, disseminated by the wind. Ovules generally borne naked on the surface of a scale, the scales spirally arranged in a short catkin which commonly matures into a woody cone. Seed-leaves several to many, sometimes only 2. Vegetative reproduction (stump-sprouting) absent or occurring only in a few species.

PINACEAE. PINE FAMILY.

Trees or shrubs, typically with one main mast-like axis which bears laterally successive whorls of much-branched limbs. In the crowded forest the lower branches are shade-killed and fall so that the trunk or axis supporting the cone-shaped crown is often naked for half or more than half its height. Leaves narrowly linear and alternate, or with bundles of needle-like leaves in the axils of scale-like (primary) leaves. Stamens and ovules in different catkins, usually on separate branches but always on same tree. Staminate catkins with numerous spirally arranged stamens, each bearing two pollen-sacs and ending in a roundish crest or mere knob; pollen-grains usually with two bladder-like appendages to assist distribution by the wind. Ovulate catkins with spirally arranged scales, each subtended by a distinct bract; ovules naked, 2 at the base of each scale on the upper side, maturing into seeds which commonly bear a wing derived from the surface tissue of the scale. Fruit a woody cone, the scales much enlarged, the bracts remaining small or sometimes elongated and surpassing the scales.—Northern hemisphere, eight genera.

Cones pendent or spreading, falling from the tree whole, the scales persistent.

Leaves of 2 kinds, needle-leaves in fascicles of 1 to 5 and scale-leaves; cones maturing the second autumn, their bracts minute. ..... 1. PINUS.

Leaves of 1 kind, linear; cones maturing the first autumn, their bracts obvious.

Bracts longer than the scales, notched at apex with a spear-like point in the notch; leaf-scars smooth; old bark very rough. .....2. PSEUDOTSUGA.

Bracts shorter than the scales; branchlets roughened by the persistent leaf bases.

Leaves sessile on the woody peg-like base which spreads at right angles to the branchlet; trunk bark marked by scars of deciduous scales.....3. PICEA.

Leaves petioled, jointed on the woody base which is somewhat decurrent on the branchlet; trunk bark fissured or smoothish, not scaly.....4. TSUGA.

Cones erect on branch, maturing the first autumn, their scales falling separately; leaf-scars smooth.....5. ABIES.

1. PINUS L. PINE.

Trees with two sorts of leaves, the primary leaves thin and scaly or chaff-like, bearing in their axils needle-shaped leaves, in fascicles of 1 to 5, which emerge from slender buds whose scarious scales sheathe the base of the cluster. Staminate catkins spreading, crowded in a whorl towards the base of the shoot of the same spring. Ovulate catkins erect, 1 to 5 in a lateral or sub-terminal whorl. Cones maturing in the second autumn, reflexed or pendulous, their scales woody, imbricated, the exposed portion often much thickened and bearing centrally an elevated scar or prickly boss (umbo). Seed-leaves 4 to 17.—Northern hemisphere, 70 species; strongly represented in California, no other region relatively to area being so rich in species. (Latin name of the pine.)

The following arrangement of species in groups is in part ecological.

WHITE PINES.—Cones subterminal, the tip of the scales usually thin and unarmed; needles in 5s; wood light-colored, soft; chiefly high montane.

Cones long-stalked, very long and slender when closed; seeds shorter than their wings.

Needles 1 to 3¾ inches long; cones 6 to 8 inches long; high ranges.....1. *P. monticola.*

Needles 2 to 3½ inches long; cones 13 to 18 inches long; high ranges.....2. *P. lambertiana.*

Cones with short stalks or almost none; needles 1 to 2½ inches long; seeds longer than their wings.

Scales very thick at tip, not closely overlapping; cones subglobose, *1 to 3 inches* long; high montane.....3. *P. albicaulis.*

Scale-tips slightly thickened, rather closely overlapping; cones commonly long-ovate, 2 to 5 inches long; desert mountains chiefly.....4. *P. flexilis.*

YELLOW PINES.—Cones subterminal, sessile or nearly so, the scales with a thickened tip which is umbonate and armed with a prickle; needles in 5s, 3s, or 2s; wood very pitchy.

Needles in 5s.

Cones oblong-ovate, 2½ to 5 inches long; scales with minute prickles; needles ¾ to 1 inch long; Mt. Whitney region and high North Coast Ranges.....5. *P. balfouriana.*

Cones slender-ovate, 3 to 3½ inches long; scales armed with long slender prickles; needles 1 to 1½ inches long; desert ranges .....6. *P. aristata.*

Needles in 3s, 5 to 10 inches long; cones breaking through near base when falling, some scales remaining on branch ("broken-cone" type).

Cones ovate, 3 to 5 inches long: common at middle altitudes.... .....7. *P. ponderosa.*

Cones round-oval, 5 to 8 inches long.....7a. Var. *jeffreyi.*

Needles in 2s, 1¼ to 2¾ inches long; cones 1 to 1¾ inches long, not breaking in two.

Foliage dark green; bark thick, rough; seashore..8. *P. contorta.*

Foliage yellow green; bark thin, smooth; high montane..... .....9. *P. murrayana.*

NUT PINES.—Cones lateral or subterminal, the scales strongly thickened at tip or prolonged into conspicuous spurs or hooks; seeds large, thick-shelled, the wing usually short or none; needles 1 to 5 in a cluster; arid areas and chiefly low altitudes.

Cones very large, with highly developed spurs, breaking through near base when falling, a few lower scales persisting on the branch ("broken-cone" type); needles in 3s.

Cones long-ovate, 10 to 13 inches long; needles erect, 5 to 14 inches long; trunk persisting through crown as one main axis; foliage yellowish: South Coast Ranges and Southern California.....10. *P. coulteri.*

Cones round-oval, 6 to 10 inches long; needles drooping, 7 to 13½ inches long; trunk branching into several secondary axes; foliage gray; dry interior foothills....11. *P. sabiniana.*

Cones with pyramidal tips to the scales.

Needles in 5s, 8 to 12 inches long; cones triangular-oval, 4 to 5½ inches long; local on south coast.....12. *P. torreyana.*

Needles commonly in 4s, ¾ to 1⅝ inches long; cones subglobose, 1¼ to 2¼ inches long; Southern and Lower California..... .....13. *P. parryana.*

Needles 1 in a place, 1½ to 2 inches long; cones subglobose, 2½ to 3½ inches long; desert region.....14. *P. monophylla.*

CLOSED-CONE PINES.—Cones lateral, sessile, one-sided, opening tardily, often remaining closed for many years, their scales conspicuously swollen at tip; needles in 3s or 2s; lower altitudes, chiefly of coast.

Needles in 2s, 4 to 6 inches long; cones broadly ovate, 2 to 3 inches long, often developing stout spurs; seashore.....15. *P. muricata.*
Needles in 3s.
Cones broadly ovoid, 2½ to 4½ inches long; needles 3 to 6 inches long; seashore.....16. *P. radiata.*
Cones oblong-ovate, 3 to 6 inches long; needles 3 to 5 inches long; montane.....17. *P. tuberculata.*

Silver Pine.

1. PINUS MONTICOLA Don. Figs. 36*b* and 8.

Needles in 5s, rarely 4s, very slender, 1 to 3¾ inches long, sheathed at base by thinnish narrow deciduous scales, some of which are 1 inch long; cones in clusters of 1 to 7, borne near the ends of high branches on long stalks, pendulous, 6 to 8 or rarely 10 inches long, very slender when closed and usually curved towards the tip, black-purple or green when young, 3 to 3½ inches thick near the base when open and tapering to the apex; scales thin, smooth, widening from the base to the rounded apex, chocolate-brown except the exposed portion which is buff and bears a terminal scar-like umbo; seeds 3 to 4 lines long, ⅓ to ½ as long as their wings which are pointed and widest at the middle (Fig. 37b); seed-leaves 5 to 9.

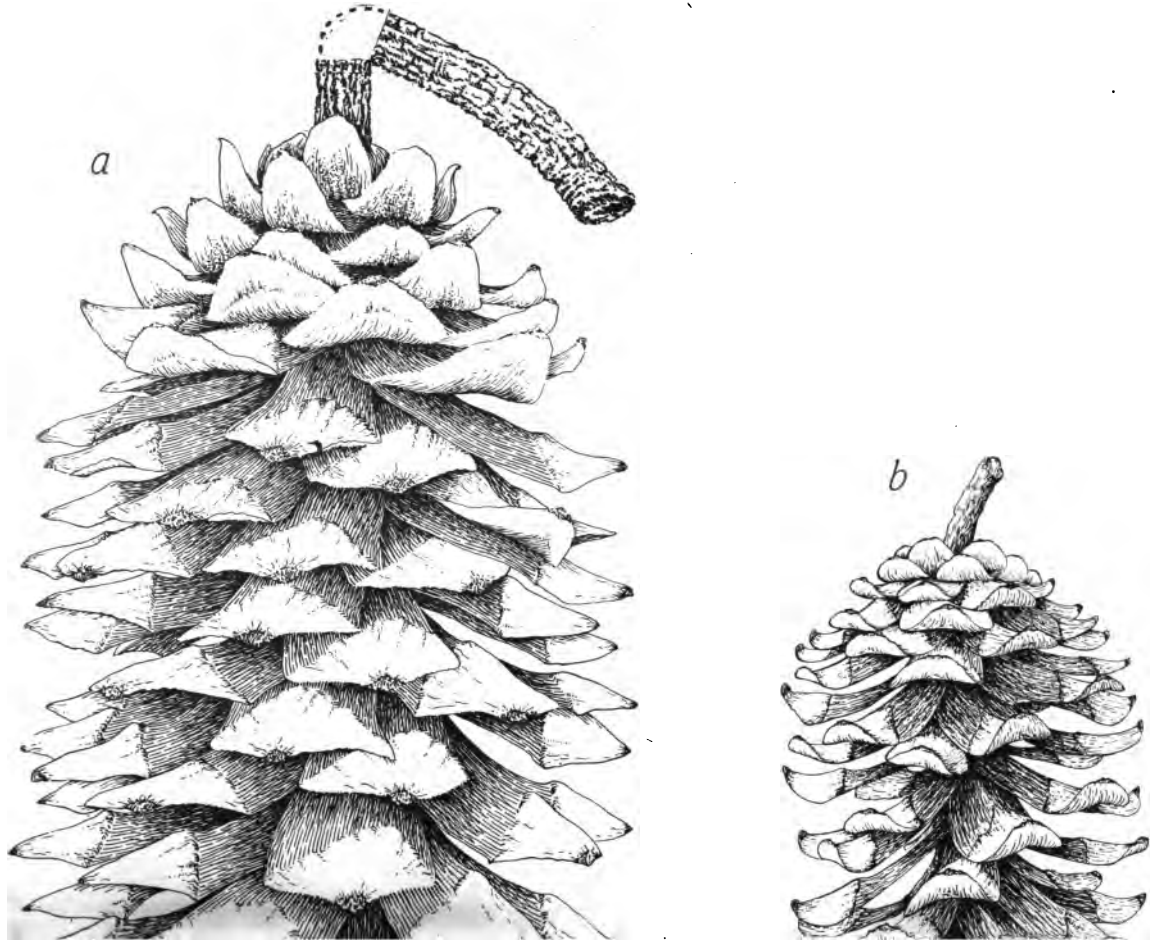
The Silver Pine, also called Western White Pine and Mountain Pine, is a forest tree 50 to 125 feet high with a trunk 1 to 4 feet in diameter. The branches are slender, somewhat drooping, or mainly horizontal, especially above, the very tip-top with a cluster of ascending or semi-upright cone-bearing branches. The whitish or reddish bark is thin, very smooth or checked into small square or rectangular plates. The foliage is blue-green and somewhat glaucous. The wood is light, soft, close- and straight-grained.

In California, Silver Pine occurs mainly in the Sierra Nevada where it is found between 5,500 and 8,000 feet at the north and 8,000 to 10,000 feet at the south. While widely scattered through the upper portion of the main timber belt, it is forestrally a rare tree and nowhere abundant except in small patches. It is found on Grayback Mt., Washoe County, Nevada, and also occurs sparingly in the far North Coast Ranges (Trinity, Marble and Siskiyou mountains). Northward it ranges to British Columbia and Montana.

Sugar Pine.

2. PINUS LAMBERTIANA Dougl. Figs. 36*a* and 27.

Needles in 5s, slender (but thicker and more rigid than in Silver Pine), 2 to 3½ inches long; cones pendulous, borne on stalks at the ends of the branches, commonly in the very summit of the tree, very long-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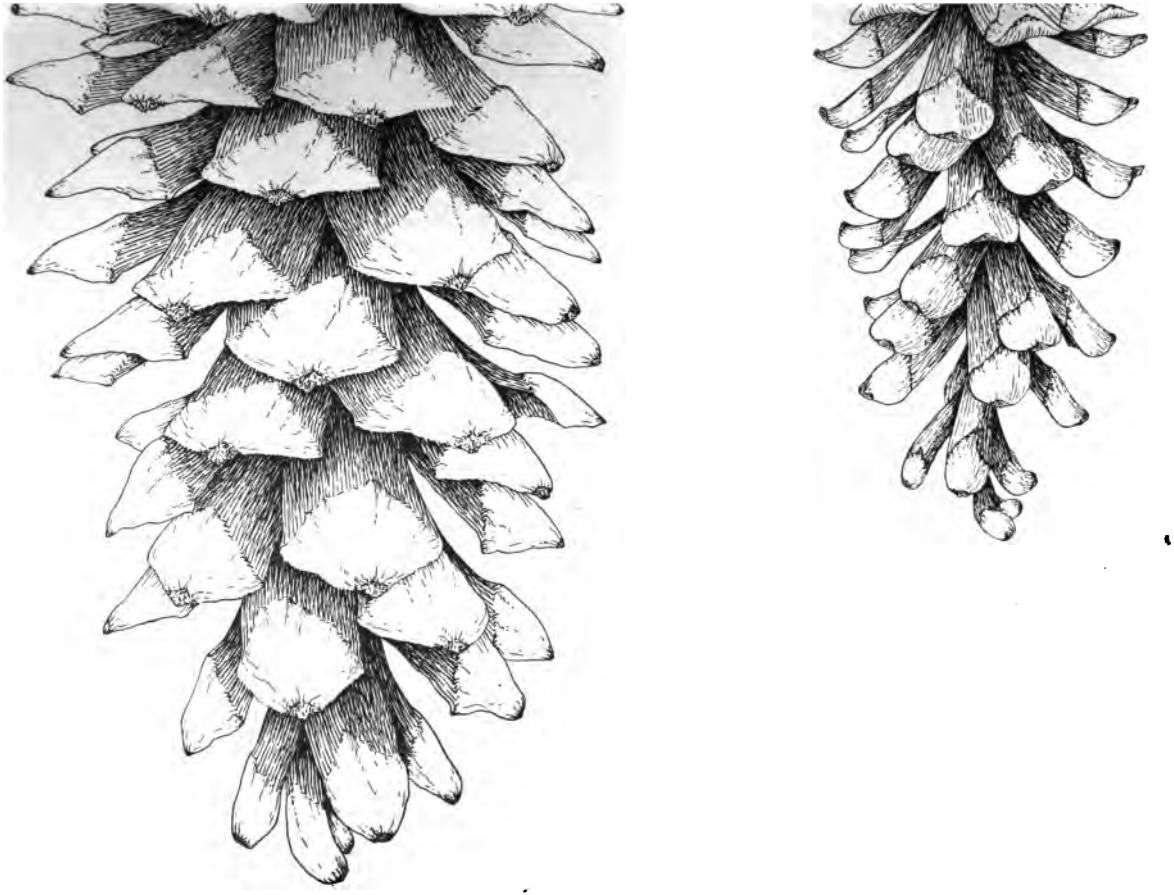

Fig. 36. *a,* SUGAR PINE (*Pinus lambertiana* Dougl.), open cone with stalk. *b,* SILVER PINE (*Pinus monticola* Don), open cone with stalk. ⅔ nat. size.

oblong, 13 to 18 inches long, 4 to 6 inches thick when opened; scale-tips thin, with terminal scar-like umbo; seeds 2 to 5 lines long with wings twice as long and broadest near the middle (Fig. 37a); seed-leaves 13 to 15.

Sugar Pine is a splendid forest tree 70 to 180 feet high. The trunk, which is 3 to 7 feet in diameter, holds its diameter well upward, is usually clear of branches for a great height, and in typical trees is surmounted by a flat-topped or irregular crown consisting of several horizontal arms of unequal length, characteristics which distinguish it from all associated species. The bark is brown or reddish, 2 to 4 inches thick, fissured longitudinally into rough ridges, the surface breaking down into small deciduous scales.

Pinus lambertiana attains its greatest development in the main timber belt of the Sierra Nevada where it is, on account of its charmingly irregular crowns, a striking feature of the forest between 3,500 and 6,500 feet at the north and 5,500 and 8,500 feet at the south. While usually forming but a small portion of the forest stand it is in limited areas the dominant species. The fine Sugar Pine forests about Crocker's and Hazel Green have been greatly admired by travelers journeying over the old-time Big Oak Flat and Coulterville wagon roads to Yosemite.

In the Coast Ranges it is comparatively scarce, being found only in the following high ranges: Siskiyou Mountains and eastward to Mt. Shasta, southward to Salmon Summit, near Hupa Valley, and abundant along the Yollo Bolly Range to Snow Mountain and Mt. Sanhedrin; Cobb Mt.; northward slopes of Mt. St. Helena; seaward Coast Range from Stewarts Point to Point Arena, about five miles from the seashore and ranging inland to Ornbaum and Austin Creek. In the South Coast Ranges it grows in the Santa Lucia Mountains and has been reported in the Coast Ranges west of Palo Alto.

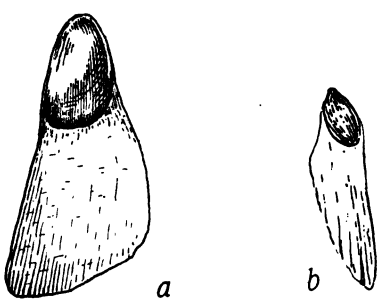

Fig. 37. *a*, SUGAR PINE seed. *b*, SILVER PINE seed. nat. size.

In Southern California it is found generally on all the high ranges from Mt. Pinos to the Sierra Madre, San Bernardino, Mt. San Jacinto and Cuyamaca mountains. It recurs on Mt. San Pedro Martir in Lower California (southermost locality). Northward it ranges to the Santiam River in southern Oregon.

Sugar Pine wood is soft, light, close- and straight-grained, very white and satiny when finished, and of high commercial value.

White-bark Pine.

3. PINUS ALBICAULIS Engelm. Figs. 38 and 3.

Needles in 5s, 1 to 2½ inches long, persisting 5 to 7 years but clothing only the tips of the slowly growing branchlets; staminate catkins globose, bright pink; cones ovoid or subglobose, yellowish brown, 1 to 3 inches long and nearly as thick; scales broad, at apex rounded and with a short acute umbo, not overlapping closely but their tips strongly thickened and either projecting freely or presenting very bluntish points; seeds obovate, acute, not compressed or only on one side, obscurely margined towards the point, ⅓ to ½ inch long; wing narrow, usually persistent on the scale; seed-leaves 7 to 9.

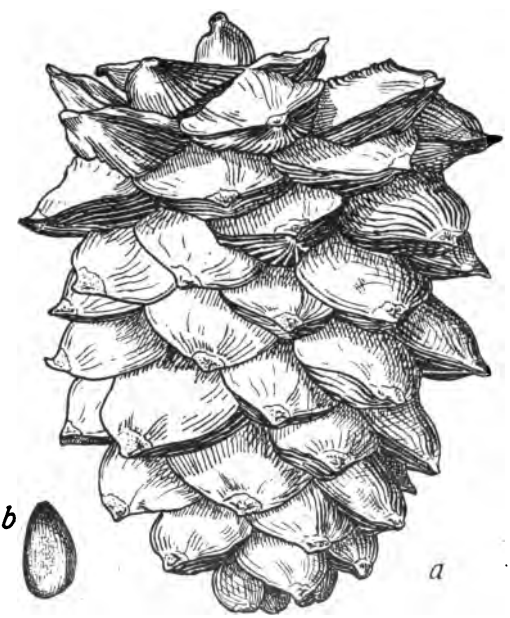

Fig. 38. WHITE-BARK PINE (*Pinus albicaulis* Engelm.). *a*, Closed cone; *b*, seed. nat. size.

White-bark Pine is a tree growing at or near timber line, often with 2 or 3 main stems from the base. In exposed situations it is usually dwarfish or prostrate and no more than 6 or 10 feet high. Trees with prostrate trunks 10 feet long and 1 to 1½ feet in diameter, or with crowns on the

ground like low flat tables 2 or 3 feet high over which one may readily walk are a characteristic feature of exposed ridges or huge cirques where snow-drifts 100 to 500 feet in depth accumulate in the winter. In protected cañons it may become 40 feet high with a single main axis from the base and ½ to 2 feet in trunk diameter. The bark is thin, whitish, smooth, or on old trunks fissured into scaly plates.

As a sub-alpine tree it is a feature of the high Sierra Nevada between 7,000 to 11,000 feet at the north and 9,500 to 12,000 feet at the south. The southermost localities are about the head of Little Kern River and on Mt. Whitney. It is frequent on Bubbs Creek, about Bullfrog Lake, Tuolumne Meadows region (Vogelsang Peak, Mts. Lyell, Dana and Gibbs, and Benson Pass), and so on north to Mt. Shasta and west to Thompson Peak in Trinity County. It ranges far north to British Columbia and east to the Rocky Mountains of Montana.

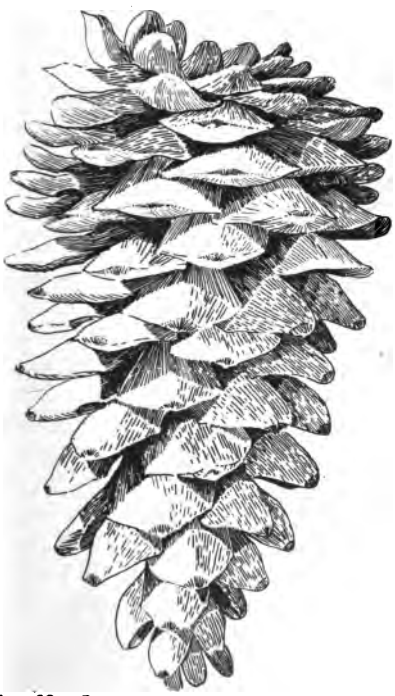

Fig. 39. LIMBER PINE (*Pinus flexilis* James). Open cone. nat. size.

Limber Pine.

4. PINUS FLEXILIS James. Fig. 39.

Needles in 5s, 1 to 2¼ inches long, often curving, densely clothing the ends of the branchlets and thus forming a sort of brush; cones buff or olive-buff, globose to long ovate, 2 to 5 inches long; scales broad with rounded slightly thickened tips and terminal scar-like umbo, overlapping rather closely and leaving only a narrow portion free on the upper side of the scale; seeds nearly oval, markedly compressed, surrounded by an acute margin, 4 or 5 lines long; wing narrow, generally persistent on scale; seed-leaves 6 to 9.

Limber Pine is a tree 10 to 60 feet high with a short thick trunk 1 to 3 feet in

diameter. The bark is dark brown, deeply furrowed and broken crosswise into nearly square plates. The branches are usually very long and long-persistent, extending down to or nearly to the ground. The foliage is dark yellow-green.

Pinus flexilis is distinctively a tree of the desert ranges in California or of desert slopes between 7,000 and 10,000 feet. It occurs on Santa Rosa Mountain, summits of San Bernardino Mountains, Sierra Madre and Mt. Pinos; on the Panamint and Inyo mountains; and on eastern wall of the Sierra Nevada from Mono Pass to Monache Peak. It is also reported on the high south wall of South Fork Kings River. It is widely distributed in the desert ranges of Nevada(where on account of the scarcity of timber it is highly valued as "White Pine") and extends east to the Rocky Mountains from Alberta to New Mexico.

Foxtail Pine.

5. PINUS BALFOURIANA Jeffrey. Figs. 40, 5, 6 and 10.

Needles in 5s, bright green on the upper side, glaucous on the lower, ¾ to 1 inch long, persisting 10 to 15 years; cones slender when closed, oblong-ovate in outline when open, terra cotta in color, 2½ to 5 inches long and 1¾ to 2 inches thick; tips of the scales thickened or low-pyramidal, with shrunken scar-like umbo; seeds 3½ to 4 lines long, their wings narrow, 6 to 11 lines long; seed-leaves 5.

Foxtail Pine, often called Balfour Pine, is a sub-alpine tree commonly 20 to 45 or rarely 55 feet high. The trunk-axis is cone-shaped, 1 to 3 feet in diameter at the base, and in old or storm-beaten trees at timber line generally projects through the crown as a dead and shining splinter point. The bark is reddish brown, smoothish but superficially checked into square plates. The branches are stout, rather short, or irregular in length, with half-drooping branchlets thickly clothed with needles spreading equally all around the stem and thus resembling a fox's tail.

Pinus balfouriana is a local species confined to two widely separated high-montane areas, one in the North Coast Ranges, the other in the southern Sierra Nevada. In the North Coast Ranges it occurs on the Scott Mountains (where it was first discovered by John Jeffrey in 1852) and on the Yollo Bollys in Tehama County. In the southern Sierra Nevada it is distributed from the head of the San Joaquin North Fork southward to Monache Peak, at altitudes of 9,000 to 12,000 feet. It

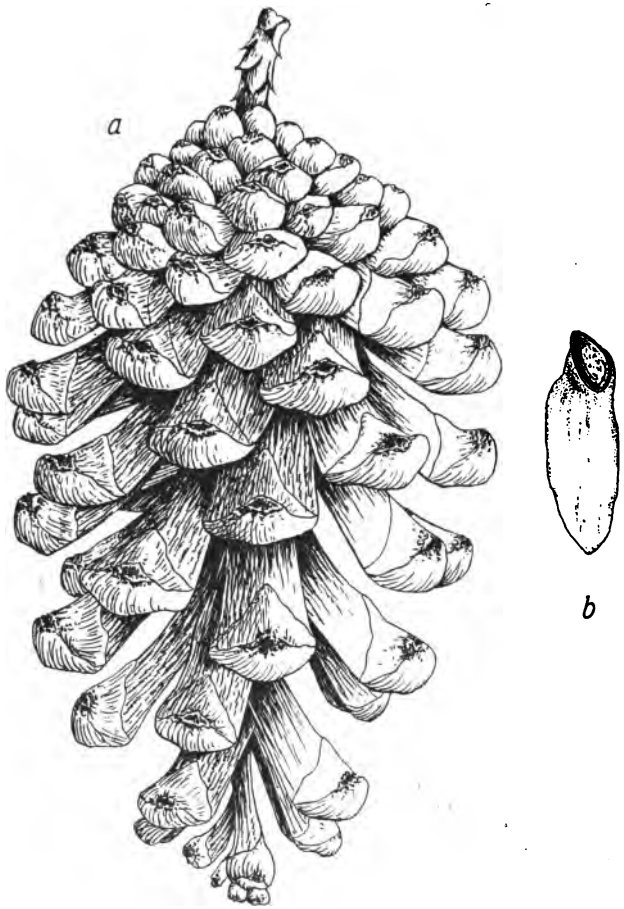

Fig. 40. FOXTAIL PINE (*Pinus balfouriana* Jeffrey). *a*, Open cone; *b*, seed. nat. size.

is abundant at Coyote Pass, on the Whitney and Chagoopah plateaus, and about Bullfrog Lake and East Vidette. It is also reported from Mt. Silliman, Alta Peaks, Kaweah Peaks, head of basins of Middle Fork Kaweah, East Fork Kaweah, Little Kern, Middle Tule and South Fork Kern.

Growing on bare elevated rocky slopes and cirques it usually forms in its areas of best development a stand of scattered trees without other associates. Typical groves, indeed, not infrequently occupy areas barren of shrubs, and of herbaceous vegetation as well. On account of its conical trunk, short branches, and short dense masses of needles Foxtail Pine shows obvious relation in its architectural form to the extreme temperature conditions and high winds of its habitat and thus lends striking interest to the isolated colonies in the high granite country, particularly in the southern Sierra Nevada.

Hickory Pine.

6. PINUS ARISTATA Engelm.

Leaves 1 to 1½ inches long; cones ovate, 2½ to 3½ inches long, the scales armed with slender prickles 3 lines long; seed-leaves 6 or 7.

Hickory Pine, also called Foxtail Pine, is a bushy tree 15 to 40 feet high, which barely enters California on the summits of the Panamint and Inyo mountains of the desert region. It is more common in southern Nevada, Utah and Colorado. In southern Nevada, on account of timber scarcity, it is valued for mine timbers.

Yellow Pine.

7. PINUS PONDEROSA Dougl. Figs. 41, 42 and 2.

Needles in 3s, 5 to 10 inches long; cones reddish brown, commonly 3 to 5 inches long, narrowly ovate when closed, roundish ovate or oval when open, after opening breaking through near the base and falling, leaving the basal scales on the limb; scales thickened or low-pyramidal at apex and bearing an umbo which is abruptly drawn down into a stout somewhat triangular point or short prickle; seeds ovatish, sometimes slightly flattened at apex, 3 to 4 lines long, the wing broadest near the middle and tapering to apex, ¾ to 1 inch long and 4 to 6 lines broad; seed-leaves 5 to 9.

Yellow Pine, more specifically Western Yellow Pine, is a forest tree of the first class, 60 to 225 feet high with long narrow open crown and trunk 2 to 8 feet in diameter. The branches in mature trees are horizontal or even drooping, the lower ones in forest stands regularly deciduous upwards, giving clear shafts 40 to 100 feet in length. Isolated trees bear very long branches nearly to the ground. The bark in typical trees is 2 to 4 inches thick, tawny or yellow-brown, divided by fissures into large smoothish or scaly-surfaced plates 1 to 4 feet long and ¼ to 1½ feet wide. Other trees and especially younger trees, or

trees of scattered colonies outside the main Yellow Pine belt, have dark red-brown bark or black bark, being respectively the indefinite "Bull Pine" or "Black Pine" of woodsmen.

Pinus ponderosa grows on fertile moist mountain slopes and plateaus, dry or rocky ridges, granite cliffs, high fertile valleys, low gravelly valleys and arid desert slopes. More widely distributed and growing in a greater variety of habitats and subject to greater ranges of temperature and precipitation than

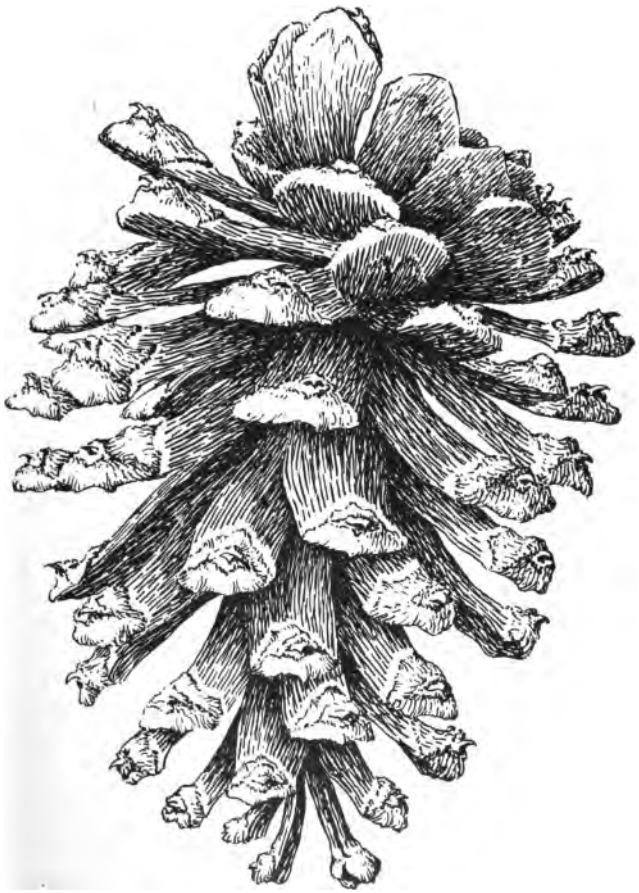

Fig. 41. YELLOW PINE (*Pinus ponderosa* Dougl.). Open cone. nat. size.

any other North American tree, it is of our Californian trees more widely distributed horizontally and vertically than any other species, it is the species most abundant in individuals, and it is (forestrally considered) of greatest commercial importance.

It generally forms the major portion of the stand in the Yellow Pine belt of the Sierra Nevada, that is between 1,500 and 5,000 feet at the north, to 3,000 to 6,000 feet in the central portion, and 5,000 to 7,000 feet at the south. Its most common associates are Black Oak, Incense Cedar, Sugar Pine and White Fir. It is common on all the high ranges of Southern California such as the Sierra Madre, San Bernardino, San Jacinto, Palomar, Santa Aña and Cuyamaca mountains. It occurs in the Santa Inez, San Rafael, and Big Pine mountains. In the South Coast Ranges it has been found in the Santa Lucia, Santa Cruz and Mt. Hamilton ranges but is absent from the Mt. Diablo and San Carlos ranges. In the North Coast Ranges it is found on the Mt. Hood, Napa, Mayacamas and Yollo Bolly ranges north to the Siskiyous, thence west to the inner margin of the fog belt at Dry Valley (Sonoma County), Ukiah, Willits, Sherwood and Blue Rock Ridge. It is also abundant in and around Mt. Shasta and ranges northeasterly over the plateaus and ranges of the Modoc lava bed country. Beyond our borders it is found throughout the Rocky Mountains and in the intermediate region north to British Columbia and south to northern Mexico and Lower California.

Fig. 42. YELLOW PINE seed. nat. size.

The wood is light or heavy, fine- and straight-grained and usually very resinous; it is pale yellow, reddish yellow or sometimes very light in color. Certain trees manufactured into lumber give planks which are practically indistinguishable from Sugar Pine and are graded in the yards with Sugar Pine stock and sold as such. "Apple Pine," which has a fragrant wood, is one of these high-grade lumberman's varieties of Yellow Pine.

The Yellow Pine is, as said above, the most abundant and widely distributed tree of California and is particularly characteristic of the Sierra Nevada, where it attains its finest development. The largest trees most commonly grow along the ridges and it is the ridges which the trails ordinarily follow. Here the

traveler may journey day after day, over needle-carpeted or grassy ground, mostly free of underbrush, amidst great clean shafts 30 to 100 feet high, of really massive proportions but giving a sense of lightness by reason of their color, symmetry and great height. No two trunks in detail of bark are modeled exactly alike, for each has its own particular finish; so it is that the eye never wearies of the fascination of the Yellow Pine but travels contentedly from trunk to trunk and wanders satisfyingly up and down their splendid columns—the finest of any pine.

Jeffrey Pine.

7a. PINUS PONDEROSA var. JEFFREYI Vasey. Figs. 3 and 8.

Jeffrey Pine is a forest tree 60 to 120 or 170 feet high, typically with rusty or wine-colored trunks, the bark broken into roughish plates. This variety, which merges insensibly into Yellow Pine, is ordinarily distinguished from the species by its larger cones which are 5 to 8 inches long. When open the cones are much denser and shaped like an old-fashioned straw hive. The prickle of the umbo is often more slender. The seeds are often obovate, 5 to 7 lines long, with a wing 12 or 13 lines long.

In its typical form Jeffrey Pine is found at elevations of 6,000 to 9,000 feet. It inhabits the San Bernardino and San Jacinto mountains, high Sierra Nevada (common on western but especially abundant on eastern slope), Mt. Shasta, Siskiyou and Scott mountains and the Yollo Bolly Range. Growing at higher altitudes than the Yellow Pine it forms thinner forests, is more often flat-topped or broken, and has a greater trunk diameter relatively to its height.

Beach Pine.

8. PINUS CONTORTA Dougl. Fig. 43.

Needles in 2s, 1¼ to 2 inches long, clothing the branchlets densely, persisting 2 or 3 years; cones when closed narrowly ovate or sub-cylindric, somewhat oblique, spreading or declined when mature, 1¼ to 1¾ inches long, opening and releasing their seeds when fully ripe, falling after 4 or 5 years or remaining on the tree many years; tips of the scales slightly raised (low pyramidal), bearing a very slender prickle which weathers away in age; seeds 2 lines long with a wing ½ inch long; seed-leaves 4 or 5.

The Beach Pine is commonly a littoral tree with dark green crown 10 to 25 feet high. The trunk is ¼ to 1¼ feet in diameter and clothed in dark roughly fissured thick bark. Typically the

Fig. 43. BEACH PINE (*Pinus contorta* Dougl.), cone. nat. size.

trees are dwarfed or with a very irregular crown owing to their exposed situation. This form is common on the Mendocino bluffs and on the sandhills at Samoa near Eureka. At Crescent City about one mile easterly from the town is a small grove, the trees 20 to 30 feet high and forming a pure stand. On the Mendocino White Plains occurs a dwarf cane-like form 2 to 5 feet high and bearing freely very slender cones.

Pinus contorta ranges from Point Arena to the sand-dunes of the Oregon and Washington coasts and northward to Alaska, its altitudinal range being from sea-level to 500 feet. In the Cascades of Oregon and Washington it passes into Pinus murrayana. Inasmuch as the extreme forms of these two are very unlike and the main geographical areas distinct it is here held convenient to retain Pinus murrayana as of subspecific rank.

Tamrac Pine.

9. PINUS MURRAYANA Balf. Figs. 44, 3 and 8.

Needles in 2s, 1 to 2¾ inches long; cones chestnut brown, oblong, more or less globose when open, 1 to 1¾ inches long; scales thickened at the ends, black-banded at their tips inside, the central umbo prolonged into a slender sub-persistent prickle; seeds 2 lines long with a wing 5 or 6 lines long; seed-leaves 4 or 5.

Tamrac Pine, the Lodgepole Pine of the Northwest, is a forest tree with symmetrical and rather dense crown, 50 to 80 or rarely 125 feet high. Sometimes it appears at timber line, as on Mt. San Jacinto and through the Sierra Nevada from Mt. Whitney north; then it is dwarfed or storm-battered, 10 to 30 feet high, or even occurring semi-prostrate. Its bark is light gray, remarkably thin, usually ¼ inch thick, very smooth but flaking off into thin scales. The wood is fine- or coarse-grained, reddish brown and hard. While little utilized in the past in California it will eventually be of commercial importance.

Pinus murrayana occurs throughout the Sierra Nevada between 5,000 and 7,000 feet in the north and 7,000 to 11,000

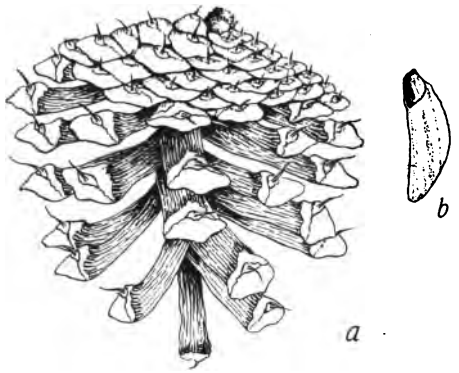

Fig. 44. TAMRAC PINE (*Pinus murrayana* Balf.). *a*, Open cone; *b*, seed. nat. size.

feet in the central and southern part. It is an especially characteristic feature of swampy meadows or moist mountain slopes where it forms dense stands, often without admixture of other species. In Southern California it is found on the Sierra Madre, San Bernardino and San Jacinto ranges. Beyond our borders it ranges east to the Rocky Mountains of Colorado and Montana and recurs on Mt. San Pedro Martir in Lower California.

Big-cone Pine.

10. PINUS COULTERI Don. Figs. 1 and 45*a*.

Needles in 3s, erect, tipped with a short hard point, 5 to 10 (or 14) inches long; cones long-ovate, 10 to 13 inches long, 5 to 7½ inches thick, when falling breaking through near the base like the cone of the Yellow Pine; scales at tip drawn out into prominent tusk-like points or spurs which towards the base of the cone on the outer side are developed into curving talon-like appendages; seeds pinkish or yellowish, 6 to 8 lines long with a wing twice or nearly twice as long; seed-leaves 10 to 14.

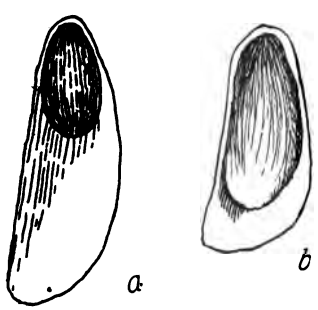

Fig. 45. *a*, BIG-CONE PINE seed. *b*, DIGGER PINE seed. nat. size.

Big-cone Pine, often called Coulter Pine, is a tree 40 to 70 feet high with rather dense conical or more often spreading crown with usually long lower branches. The foliage is yellowish green. The trunk is 1 to 2½ feet in diameter; the bark is dark, roughly broken so as to form an irregular network of longitudinal fissures and sometimes loosening superficially into long thinnish scales.

Pinus coulteri grows on dry or

rocky mountain slopes at 2,500 to 6,000 feet, chiefly on the lower margin of or below the Yellow Pine belt wherever it occurs in Yellow Pine region. It is most abundant on the San Bernardino and Sierra Madre mountains, ranging south to San Jacinto, Palomar, Santa Aña, Cuyamaca, Balkan and Laguna mountains, and into Lower California. Northward it occurs on the Santa Inez, San Rafael, Santa Lucia, Gabilan, San Carlos and Mt. Hamilton ranges. On Mt. Diablo, the most northerly locality, a few trees occur about Mitchell Rock on the north side of the mountain near the village of Clayton at 800 feet altitude.

While having a general resemblance to young Yellow Pine, Big-cone Pine is a very different tree and is easily recognized by its heavier masses of foliage, stout twigs, and its great cones with their eagle's-claw appendages to the scales.

Digger Pine.

11. PINUS SABINIANA Dougl. Figs. 46, 47 and 45*b*.

Needles in 3s, drooping, 7 to 13½ inches long; cones on stalks 2 to 2½ inches long, ovate, subglobose when open, 6 to 10 inches long, 5 to 7 inches thick and only slightly unsymmetrical, remaining on the tree one to seven years after releasing their seeds, when falling breaking through near the base and leaving the basal portion on the limb ("broken-cone" type); tips of the scales strongly developed into triangular hooks projecting downwards, about 1 inch long; seeds hard shelled, oblong, slightly flattened, slightly ridged towards the micropyle, 9 to 11 lines long, 4 to 5 lines wide, bearing a short wing 3 to 5 lines long and ½ inch broad; seed-leaves 11 to 17.

Digger Pine is a singular tree 40 to 50 or occasionally 90 feet high with a very open crown and thin gray foliage. The trunk is 1 to 4 feet in diameter, frequently slanting, commonly branching at 5 to 15 feet from the ground into a cluster of slender erect branches which form a broom-like top. Rarely one sees a tree in which the trunk-axis bears only lateral branches and persists through the crown. The bark is dark gray, roughly furrowed.

Pinus sabiniana grows in dry hot foothills and sometimes in gravelly valleys, chiefly between 50 and 2,000 feet altitude, although frequently reaching 5,000 feet at the south. It always occurs as a scattered growth, often by itself or if with other trees most commonly with Blue Oak. In the Coast Ranges it is widely although not continuously distributed, occurring in the Gabilan, San Carlos, Mt. Hamilton, Mt. Diablo, Napa, Vaca

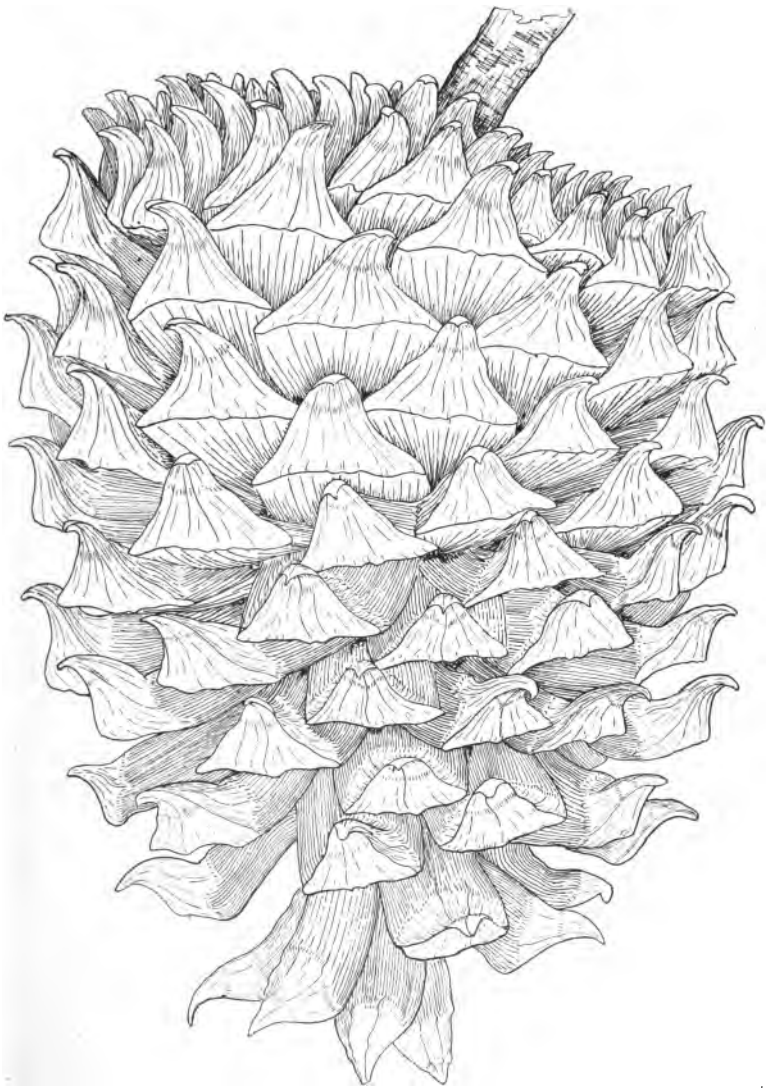

Fig. 46. DIGGER PINE (*Pinus sabiniana* Dougl.). Open cone, ⅔ nat. size.

and Mayacamas mountains. It does not grow in the summer fog belt of the North Coast Ranges (Redwood region) although it reaches the coast in the Santa Lucia Mountains (South Coast

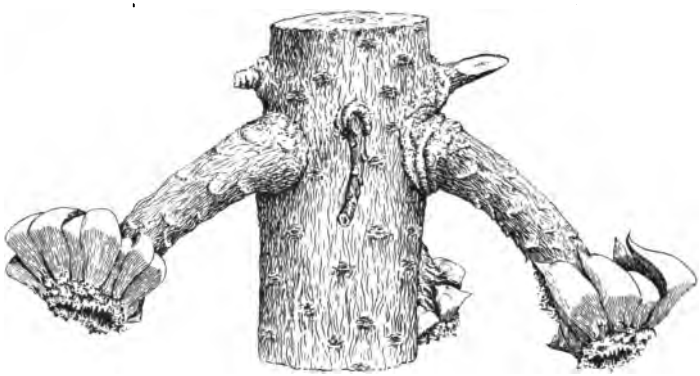

Fig. 47. DIGGER PINE. Branch with whorl of three cone-stalks, the stalks bearing the persistent scales which parted from base of cone.

Ranges) and is scattered along the east slope of the Santa Cruz Mountains. In the Sierra Nevada foothills it is the most characteristic tree of that area where it is usually the only pine except at its upper limits. It ranges south to Tehachapi and the Sierra Liebre, north to the Sacramento River cañon and the cañon of the South Fork of Salmon River near Bennet.

Torrey Pine.

12. PINUS TORREYANA Parry. Fig. 48.

Needles in 5s, 8 to 12 inches long; cones triangular oval, 4 to 5½ inches long, the scales at apex thickened into heavy pyramids; seed-leaves 12 to 14.

Torrey Pine is a low crooked or sprawling tree 15 to 35 feet high, or sometimes straight and 60 feet high. It is local on the San Diego coast about Del Mar near the mouth of the Soledad River, extending southward toward San Diego about 8 miles and inland about 1½ miles. It also occurs on Santa Rosa Island. It is remarkable for its peculiar cones, its very long needles and especially for its very restricted habitat which has attracted to it a great deal of attention. The San Diego trees are now protected in an extensive municipal park which is an

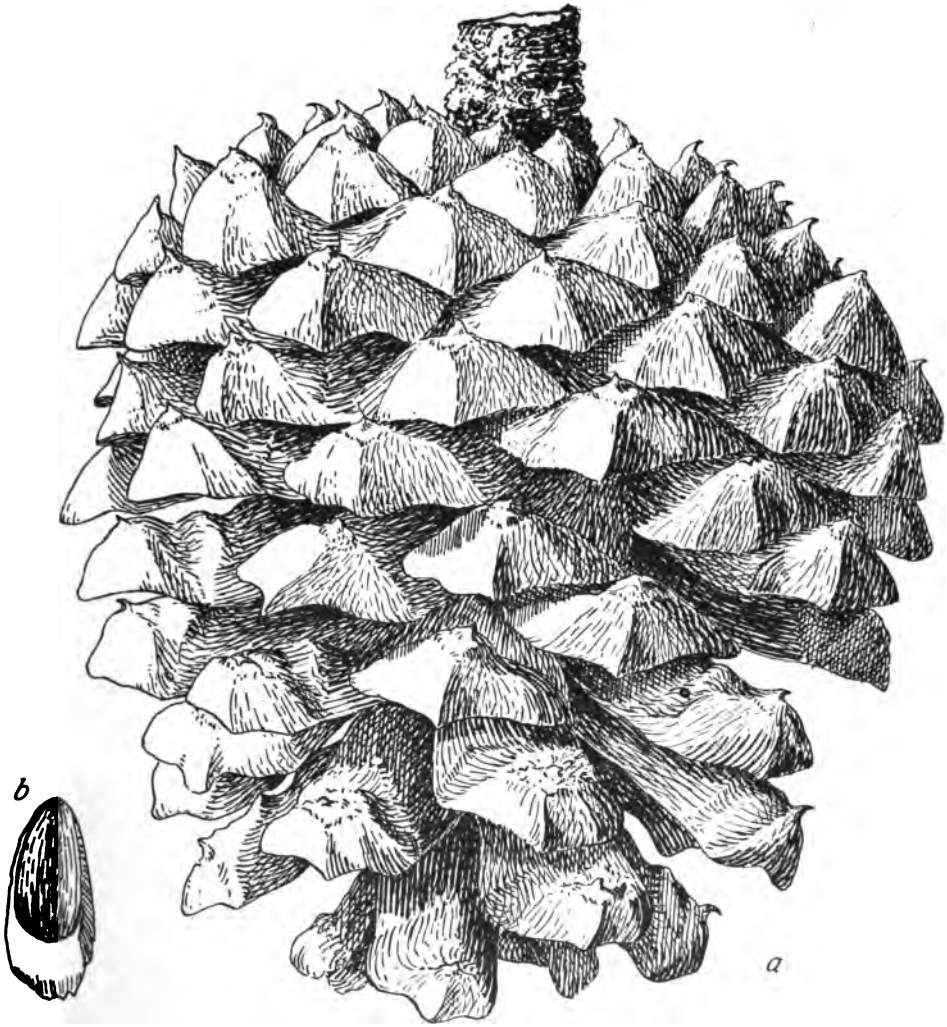

Fig. 48. TORREY PINE (*Pinus torreyana* Parry). *a*, Cone; *b*, seed. nat. size.

extremely gratifying expression of popular appreciation of unique natural features.

Parry Piñon.

13. PINUS PARRYANA Engelm. *P. quadrifolia* Sudw.

Needles ¾ to 1⅝ inches long, usually 4 (sometimes 2, 3, or 5) in a cluster; cones subglobose, 1¼ to 2¼ inches long; seeds with rudimentary wings; seed-leaves 6 to 8.

Parry Piñon, or Four-leaf Pine, is a short-trunked low tree, 15 to 30 feet high. It inhabits the dry mountains of Lower California from San Pedro Martir northward, extending into Southern California where it occurs sparingly in the intramontane region. The following are the known stations in California: near Julian; Larkin Station; slopes near Coyote Cañon; mesa at west base of El Toro; Nigger Jim Hill.

One-leaf Piñon.

14. PINUS MONOPHYLLA Torr. Figs. 49 and 9.

Needles 1 in a place, cylindric, curving upward and ending in an abrupt point, 1¼ to 2 inches long, persisting 7 or 8 years; cones subglobose, chocolate-brown or yellow, 2½ to 3½ inches in diameter; scales thick, raised at ends into high broad-based pyramids with slightly umbilicate or flattened summits bearing a minute prickle; seeds dark brown, oblong in outline, slightly flattened, ¾ inches long, without wings; seed-leaves 7 to 10.

One-leaf Piñon, the "Nut Pine" of the Nevada ranges, is most commonly a low round-headed tree with very short trunk, remotely suggestive of an old apple tree, 8 to 20 or sometimes 45 feet high. It grows on arid slopes or rocky walls and ranges through the desert regions of Utah, Nevada,* Arizona westward to the desert ranges of California (White, Panamint and Providence mountains, eastern wall of the Sierra Nevada, Tehachapi Mountains, San Emigdio, Mt. Pinos, and San Rafael Mountains, thence along the desert slopes of the Sierra Madre, San Bernardino and San Jacinto ranges, and so on south into Lower California. On the west slope of the Sierra Nevada it occurs in a few circumscribed localities, in Piute Cañon near Pate Valley (Grand Cañon of the Tuolumne River), Kings River, along the west wall of the Kern Cañon and southward into the lower Kern country.

*Ranges as far north as Mt. Davidson.

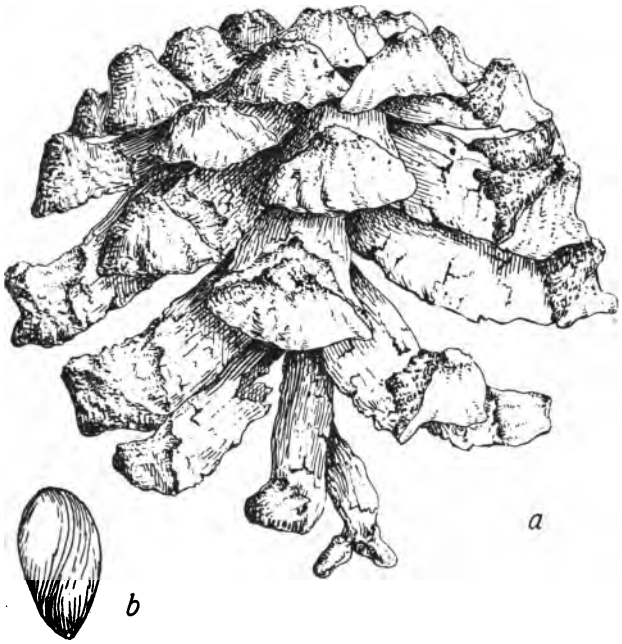

Fig. 49. ONE-LEAF PIÑON (*Pinus monophylla* Torr.). *a*, open cone; *b*, seed. nat. size.

Bishop Pine.

15. PINUS MURICATA Don. Figs. 50 and 11.

Needles in 2s, 4 to 6 inches long; cones broadly ovate, acute, 2 to 3 inches long, almost as thick, or when open more or less globose, borne on the tree in circles of 3, 4 or 5, gradually turned downward, developed more strongly on the outside towards the base and in consequence always one-sided; scale tips rhomboidal, bearing a central prickle with a broad base, or the highly developed scales towards the base on the outside standing out as very stout straightish or upwardly curving spurs; seeds black, sometimes mottled, the thin shell minutely roughened on the surface, 2½ to 3 lines long; wing broadest above the middle, oblique at summit, 5 to 8 lines long, 2½ to 3½ lines broad; seed-leaves 4 to 7.

Bishop Pine is a tree 40 to 80 feet high with roundish or flat crown and trunk 1 to 3 feet in diameter. The bark is 1 to 1½ inches thick, dark red in section, brown on the surface

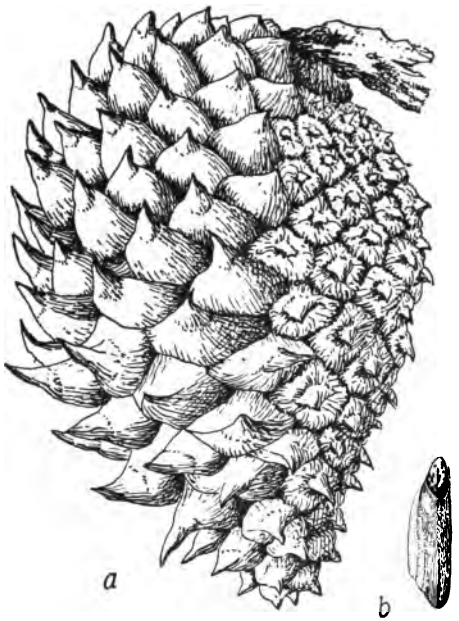

Fig. 50. BISHOP PINE (*Pinus muricata* Don). *a*, Closed cone; *b*, seed.

and broken into rough ridges. The trunk from near the ground to its summit and all the main branches bear circles of cones which persist for an indefinite period, often 15 to 25 years, and give the tree a most remarkable appearance.

Pinus muricata grows on low swampy hills, swampy flats or rocky hills, always near the ocean beach or within a few miles of it. It ranges from the wet flats of the Mendocino coast (Inglenook to Ft. Bragg) southward to the Sonoma County coast where it reaches its greatest development, forming pure groves of small extent on the low swampy hills. It also occurs on the rocky and clay hills of the Point Reyes Peninsula on the eastward slope of the Inverness Ridge from near Tomales Point southward nearly to Bolinas Bay. South of the Golden Gate it occurs on Huckleberry Hill at Monterey and near San Luis Obispo where it was originally discovered in 1830 by Dr. Thomas Coulter, a botanical traveler. The original station suggested the common name, Bishop Pine, but the scale tips thickened at the tip like a bishop's cap also emphasize the happiness of the vernacular appellation.

The wood of Bishop Pine is very resinous, light, hard and rather coarse-grained. It is sometimes used for piling as the light-brown heartwood is very durable. The tree is at present of most economic importance as a wind-break.

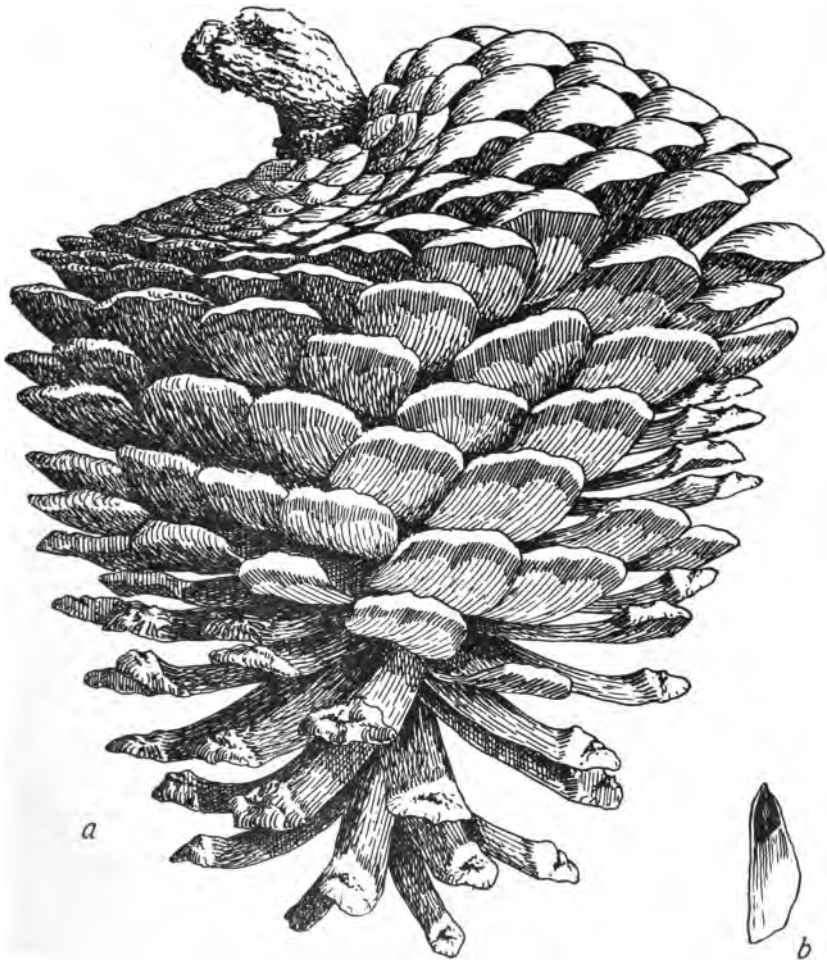

Fig. 51. MONTEREY PINE (*Pinus radiata* Don). *a*, Open cone; *b*, seed. nat. size.

Monterey Pine.

16. PINUS RADIATA Don. *P. insignis* Dougl. Figs. 51 and 52.

Needles in 3s, or a few in 2s, 3 to 6 inches long; cones tan or cinnamon color, turned downward, sessile and unequally developed, broadly ovoid and bluntly pointed, or globose when open, 2½ to 4½ inches long; scales on the outer side toward the base conspicuously developed or swollen at tip into a hemispherical or pyramidal tubercle or boss and armed with a prickle which usually weathers off; seeds black, minutely roughened on the surface, 3 lines long, bearing a broadly oblong brown wing 2½ to 3 times as long; seed-leaves 5 to 7.

Monterey Pine is a beautiful symmetrical tree or in age with flattened or broken top, 30 to 70 or 115 feet high. The foliage is a rich dark green. The trunk is 1 to 4 feet in diameter and clothed with a roughly fissured bark which is hard and more nearly black than that of any other Californian pine.

Pinus radiata grows on dry rocky or sandy hills near the sea and is confined to a few limited localities, namely, Pescadero, Monterey and San Simeon, all on the Californian mainland, and Santa Rosa, Santa Cruz and Guadalupe islands off the south coast. It is abundant locally in Monterey where it covers with a dark green forest the low range of hills half encircling the town, extends southward to Carmel Bay, and in scattered colonies to Malpaso Creek a few miles south of Pt. Lobos.

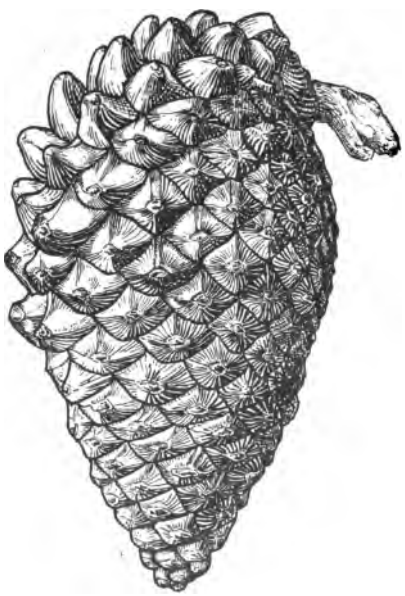

Fig. 52. MONTEREY PINE, closed cone, small type. nat. size.

It grows rapidly, attains its maturity in 30 to 50 years, and on account of its hardiness and adaptability to thin soils it has been used for windbreak and cover in the San Francisco Bay region. It has also been carried to various parts of the earth and has a wider horticultural dis-

tribution than any other Californian tree. Its wood is in some respects inferior but it will in time be valued as a second-grade or substitute timber.

Knob-cone Pine.

17. PINUS TUBERCULATA Gord. *P. attenuata* Lemm. Fig. 53.

Needles in 3s, 3 to 5 inches long; cones strongly deflexed, buff in color, narrowly ovate, oblique, acutely or bluntly pointed and somewhat curved, especially at tip, 3 to 6 inches long; scales moderately thickened at tip, except on the outside towards the base where they are raised into conspicuous rounded or pointed knobs; umbos small and contracted into slender usually deciduous prickles; seeds brownish black, ovatish, 3 to 4 lines long, the surface minutely roughened; wings 9 to 12 lines long, 3 to 4 lines broad, broadest near the middle; seed-leaves 5 to 8.

Knob-cone Pine is a tree 5 to 30 or sometimes 90 feet high with a thin crown and a slender trunk ⅓ to 1 foot in diameter. The foliage is pale yellow-green and rather thin. It grows chiefly between 2,500 and 4,000 feet, on rocky slopes or ridges, the most hopelessly inhospitable and desolate stations for tree growth in the mountains of California.

Pinus tuberculata occurs in the Coast Ranges and Sierra Nevada, extending south to Southern California and north to southwestern Oregon. Its range is exceedingly discontinuous or broken, the localities being comparatively few and widely separated. Moreover the localities, except at the north, consist of a scattered stand of a relatively small number of individuals. The known localities are as follows: San Bernardino Mountains; Santa Lucia Mountains; Santa Cruz Mountains; Moraga Ridge; Mt. St. Helena; Highland Springs; near Red Mountain (Mayacamas Range); near Mt. Konokti; Bartlett Springs to Long Valley; Bartlett Mountain; Cañon Creek near Dedrick; near Trinity Summit; Devil's Backbone near Salmon Summit; Scott Mountains; Marble Mountain; Klamath Range, both slopes; Siskiyou Mountains; lava beds of southeastern Siskiyou County; Sacramento River Cañon; lower McCloud River; northern Sierra Nevada; Forest Hill; Lynchburg; ridge above Horseshoe Bar; Merced River; Kinsley (Mariposa County), southermost locality in Sierra Nevada.

2. PSEUDOTSUGA Carr. FALSE SPRUCE.

Large trees with flat short-petioled leaves spreading around the stem or on horizontal branches often somewhat 2-ranked. Staminate catkins axillary, the pollen-sacs tipped with a spur

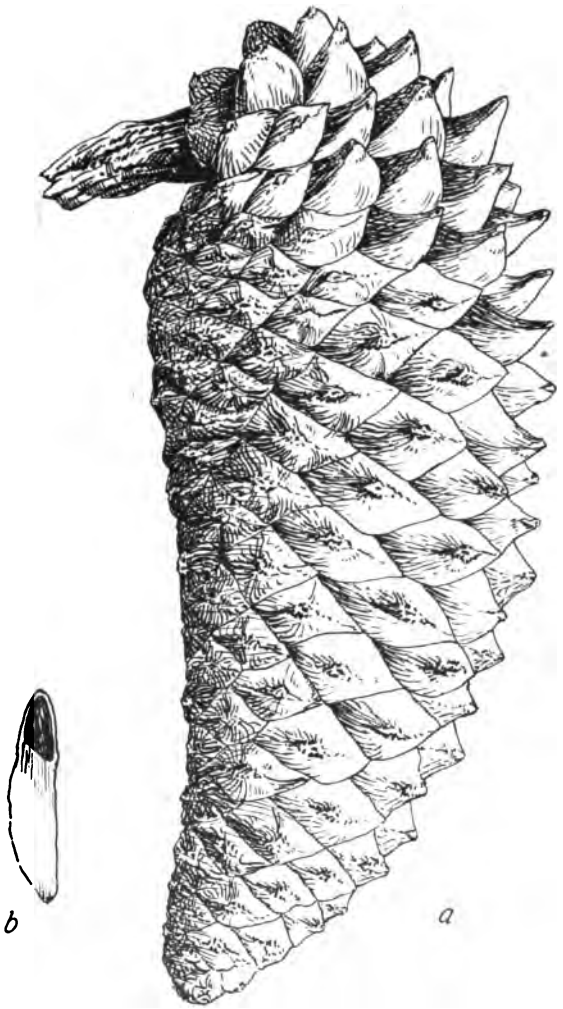

Fig. 53. KNOB-CONE PINE (*Pinus tuberculata* Gord.). *a*, Closed cone; *b*, seed. nat. size.

and opening obliquely. Ovulate catkins erect, terminal or axillary. Cones pendent, maturing in the first autumn, borne all over crown; scales thin, rounded, shorter than the slender acutely 2-lobed bracts which bear a spear-like point in the notch. Seeds without resin vesicles; seed-leaves 5 to 12.—Three species, two in America and one in Japan. In botanical relationship it stands in an intermediate position among the Spruces, Hemlocks and Firs. Its peculiar cone bracts, signally different from those of any other conifer, and the obliquely dehiscing pollen-sacs are the chief marks of the distinctive genus Pseudotsuga. (Greek pseudos, false, and Japanese tsuga, hemlock.)

RELATIONSHIP OF PSEUDOTSUGA.

Spruce-like characters.	*Hemlock-like characters.*
General habit, character of branching.	Leaves petioled, blunt.
Pendulous branchlets.	Leader of young trees often pendent.
Leaves spreading all around stem.	Cones pendent.
Cones pendent, borne all over tree, of much the same shape and size as those of spruces.	Cone-scales persistent.
Cone-scales persistent.	*Fir-like characters.*
Seeds without resin vesicles.	Bark thick, roughly fissured, not scaly as in spruces.
	Resin pockets in young bark.
	Bracts exserted.

Pseudotsuga is most nearly related to the Spruces from which it differs in its peculiar bracts and pollen-sacs. It differs from the Hemlocks in its peculiar cones and pollen-sacs; the resin vesicles of Hemlock seeds are not found in Pseudotsuga. From the Firs this genus differs very greatly in wood, foliage and character of cones. Fir cones, moreover, are borne erect and fall to pieces on the tree.

Cones 1¾ to 3½ inches long; central and northern California.....
.....1. *P. taxifolia.*
Cones 4 to 7½ inches long; Southern California.....2. *P. macrocarpa.*

Douglas Fir.

1. PSEUDOTSUGA TAXIFOLIA Britt. *P. douglasii* Carr. Fig. 54.

Branchlets with the leaves spreading all around the stem or on horizontal branchlets turned more or less to right and left but not in truly flat sprays; leaves linear, blunt at apex, flat with a median groove above and a ridge below, green, with two pale longitudinal bands on the under surface, very short-petioled, ½ to 1½ inches long, ½ to 1 line wide; cones cinnamon or red-brown, long-oval and more or less pointed, 1¾ to 3½ inches long, when open 1¼ to 1¾ inches

thick; scales broad and rounded at apex; bracts conspicuously exserted, broadly linear and bearing in the deep notch at apex a spear-like point; seeds 3 lines long, almost as long as the wings; seed-leaves 5 to 8.

Douglas Fir, often called Douglas Spruce, is a magnificent forest tree 70 to 250 feet in height, in dense stands exhibiting clear trunks 100 to 150 feet high, 4 to 8 feet in diameter and surmounted by a pyramidal or flattish crown. The bark on young trees is smooth, gray, or mottled, on older trunks 1 to 6½ inches in thickness, soft or putty-like, dark brown, fissured into broad heavy furrows, in cross-section showing alternate layers of red and white. The branchlets are usually drooping.

Pseudotsuga taxifolia inhabits fertile mountain slopes, moist cañons, dry gravelly valleys and rocky ridges and with us favors north or east slopes. It is found from sea-level to 4,000 feet, nearly throughout the North Coast Ranges, associated with Redwood in the Redwood Belt and with the Tan Oak in the middle ranges. In the inner ranges it is less common, or altogether absent as in the Vaca Mountains. In the South Coast Ranges it is found in the Santa Cruz and Santa Lucia ranges but is absent from the Mt. Diablo, Mt. Hamilton, Gabilan and San Carlos ranges. In the Sierra Nevada it occurs chiefly between 2,500 and 6,000 feet and ranges as far south as Stevenson Creek on the San Joaquin River (south limits in Sierra Nevada). Beyond our borders it ranges north to British Columbia and through the Rocky Mountains to northern Mexico.

In Washington and Oregon where it reaches its most splendid development it occurs in great abundance and furnishes the most important and widely used structural timber in western America under the name of "Oregon Pine." No other conifer yields wood of such lightness, strength, flexibility and durability. On account of its large size, timbers for bridges, big buildings and ship construction can be had ranging from the smaller grades of scantlings to sticks 1 or 2 feet square and up to 100 or 200 feet in length. Incredible as it may seem some of these large sizes are regularly quoted in trade lists.

By reason of the hardiness of the tree, its rapid growth, strong reproductive power and adaptability to a wide range of conditions, it is, in view of its wood value, an unequalled species forestrally for its region and destined to play a large part in scientific forest operations of the future, especially in the Pacific Northwest.

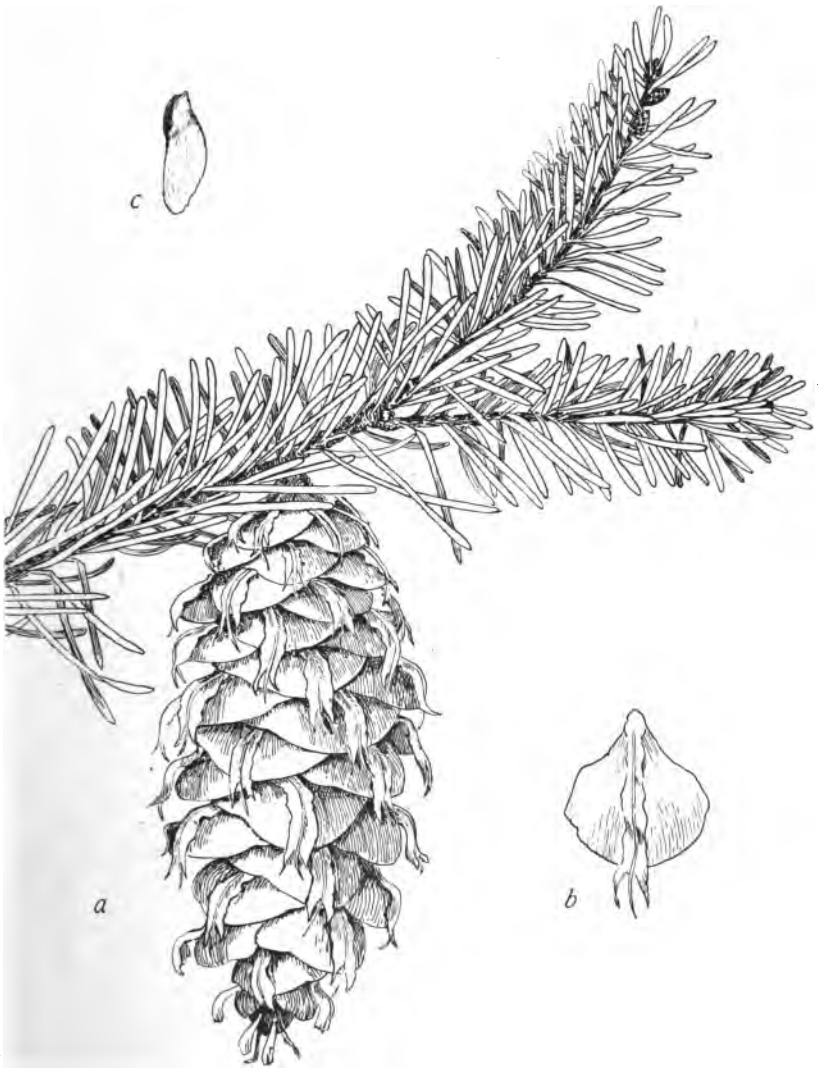

Fig. 54. Douglas Fir (*Pseudotsuga taxifolia* Britt.). *a*, Cone-bearing branchlet; *b*, scale and bract; *c*, seed. nat. size.

Big-cone Spruce.

2. PSEUDOTSUGA MACROCARPA Mayr.

Leaves slightly curved; cones 4 to 7½ inches long, 2¼ to 3 inches thick when open; bracts protruding little or not at all beyond the scales, except the lowest, the tails of which are often as much as ¾ inch long; seed-leaves 6 or 7.

Big-cone Spruce is a tree 30 to 90 feet tall with a broad pyramidal crown and very long lower branches. The bark is dark or black. In most respects this species is very similar to its near relative, the Douglas Spruce or Douglas Fir. It grows on the sides of sheltered cañons or ravines or on cool north slopes at altitudes just below the Yellow Pine (mainly between 3,000 and 5,000 feet) and forms small groves or colonies, usually growing by itself. It is distributed from the San Emigdio Range westward to the San Rafael and Santa Inez ranges, south to the Sierra Madre, San Bernardino, San Jacinto, Santa Aña, Palomar and Cuyamaca mountains. It also recurs on Mt. San Pedro Martir in Lower California. Its wood is fine-grained, tough and hard but yields a coarse lumber remarkably inferior to that of its high-class relative, Douglas Fir.

3. **PICEA** Link. SPRUCE.

Trees with tall tapering trunks and thin scaly bark. Leaves narrowly linear, spreading on all sides, jointed near the stem, the lower portion persistent after leaf-fall as a prominent woody base or spreading "peg"; resin-canals in ours 2. Catkins from terminal or axillary winter buds. Staminate catkins erect or nodding; pollen-sacs with nearly circular toothed crests, opening longitudinally. Ovulate catkins erect. Cones maturing in the first autumn, pendent, scattered over the crown generally or the upper half of the crown; scales thin, the bracts shorter than the scales. Seeds without resin vesicles; seed-leaves 4 to 15.—About 12 species, 7 in North America, the remainder in Europe and Asia. (Picea, supposedly the spruce of the Latins.)

Leaves prickle-pointed; cone-scales serrulate; coastal....1. *P. sitchensis.*
Leaves merely acute; cone-scales entire; subalpine.....2. *P. breweriana.*

Tideland Spruce.

1. PICEA SITCHENSIS Carr. Fig. 55.

Leaves spreading equally around branchlets but not straight down on the under side of horizontal ones, linear, ½ to 1 inch long, ⅔ to 1

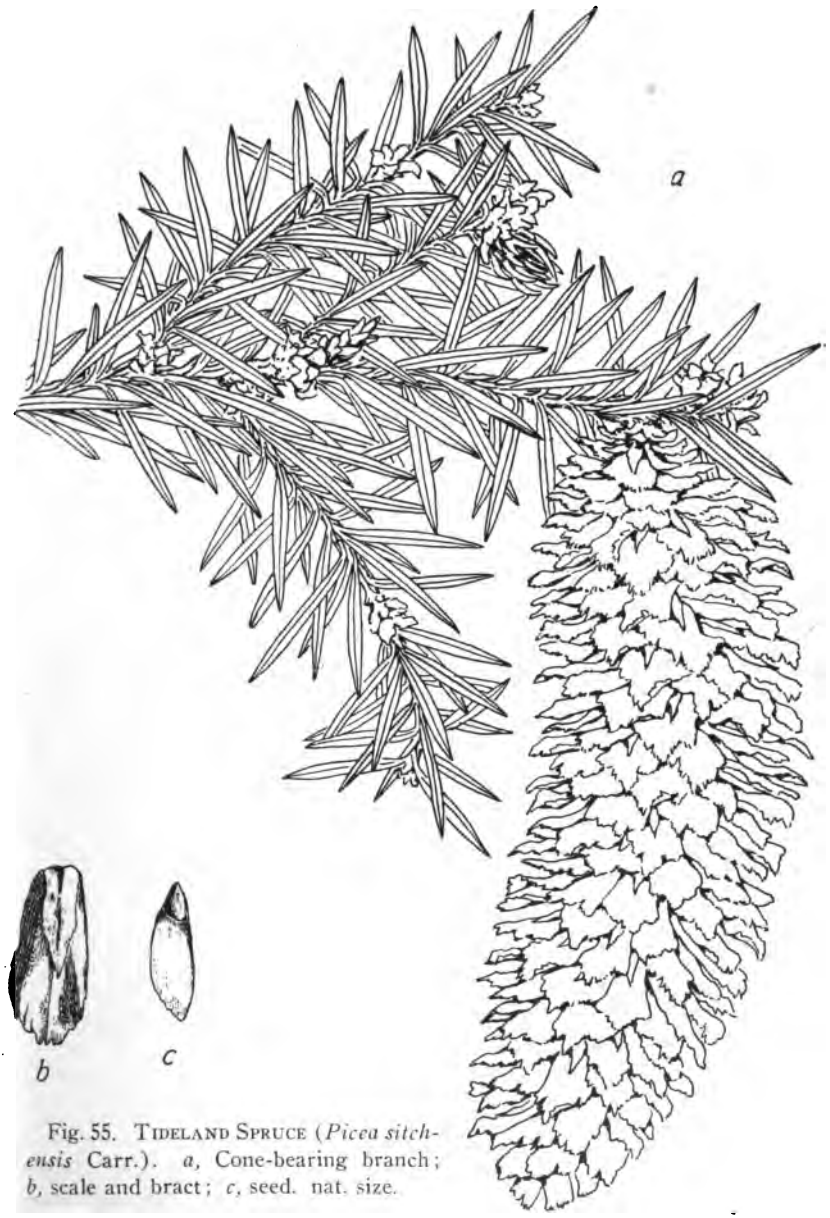

Fig. 55. TIDELAND SPRUCE (*Picea sitchensis* Carr.). *a*, Cone-bearing branch; *b*, scale and bract; *c*, seed. nat. size.

line wide, whitened and flat above but with a median ridge, convex or strongly ridged below, very stiff and usually tapering to a prickly point or in top of tree less sharp or bluntly pointed; cones dull brown, long-oblong, 2 to 4 inches long and when open 1¼ to 1½ inches in diameter; scales narrow, finely and irregularly toothed, with ovate-lanceolate bracts ½ to ⅔ as long; seeds 1⅓ lines long, the oblong wing 3 to 4 lines long; seed-leaves 4 or 5.

Tideland Spruce is a handsome forest tree 75 to 180 feet high with conical crown, wide-spreading rigid branches and drooping branchlets. The trunk is 3 to 20 feet in diameter at the base where it flares most remarkably in older trees; at 6 or 8 feet above the ground the trunk diameter may be only half that at the base. The trunk bark is reddish brown, developing roughish deciduous scales but these are not so sharply defined as is usual in spruces. Cones are borne in great abundance and over the crown generally.

Picea sitchensis inhabits lowlands or moist forests near the sea. It occurs on the Mendocino coast from Noyo to Fort Bragg, on the lowlands at mouth of Eel River, the sand-hills at Samoa, flats at Crescent City and in the western margin of the main Redwood Belt of Del Norte. Northward it ranges to Alaska. In Oregon, Washington and British Columbia it grows to almost vast proportions and is an important timber tree. The wood is light, soft, straight-grained, and makes an excellent saw-log. As a cultivated conifer it is well known under the name of Sitka Spruce.

Weeping Spruce.

2. PICEA BREWERIANA Wats. Fig. 56.

Leaves borne all round the stem, ½ to 1 inch long, roundish and green below, whitish above on either side the conspicuous median ridge, obtuse; cones narrowly cylindrical, 3½ to 4½ inches long, 1¼ to 1½ inches thick when open; scales rounded at apex, very thick for a spruce and with smooth entire edges; bracts oblong, acute, ⅕ to ¼ as long as the scales; seeds 1½ lines long, with wings 4 lines long; seed-leaves 6.

Weeping Spruce, sometimes called Brewer Spruce, is a subalpine tree 20 to 95 feet high with a rather broad crown. The branches clothe the trunk to the ground; they are few and mainly horizontal, especially in the top, and ornamented with cord-like branchlets 1 to 6 feet long hanging straight down, thus giving a formal effect to the stiffish and very thin crown. The trunk is ½ to 3½ feet in diameter, its bark thin (½ inch thick), whitish and smoothish on the surface

Fig. 56. WEEPING SPRUCE (*Picea breweriana* Wats.). *a*, Branchlet with open cone; *b*, scale and bract. nat. size.

but presenting shallowly concave scars from which have fallen thick scales of irregular shape, mostly 1 to 4 inches long and half as wide (Fig. 57). The cones are borne in the top of the crown, mostly in clusters.

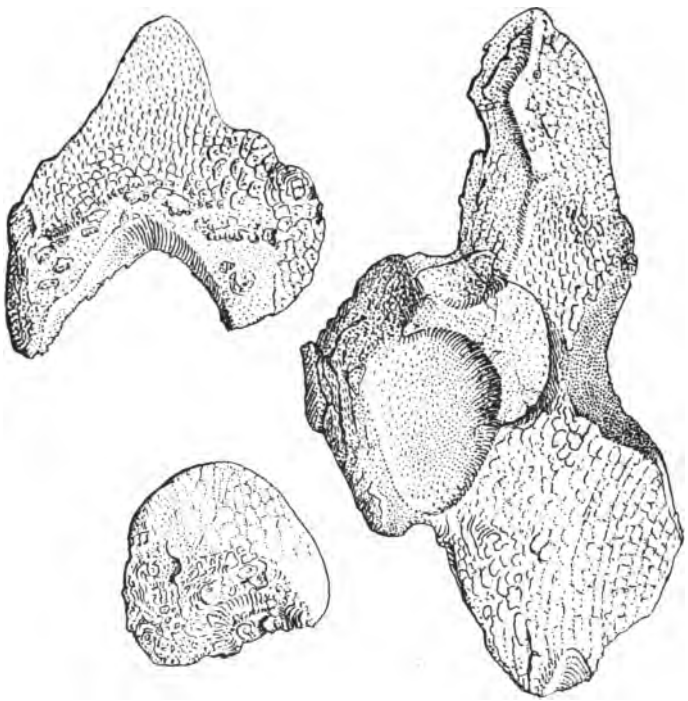

Fig. 57. WEEPING SPRUCE (*Picea breweriana* Wats.). Scales which have fallen from the trunk bark. nat. size.

Picea breweriana grows on cool moist slopes at altitudes of 6,000 to 8,000 feet and is confined to the summits of a few high ranges in northwestern California and adjacent Oregon. The following are the known stations in California: Klamath Range; Siskiyou Mountains; Marble Mountain; South Russian Creek on North Fork Salmon River; Thompson Peak, Salmon Mountains. In Oregon it is reported from the Oregon Coast Range, Chetco Range, and high mountain tops south

of Rogue River. Near Marble Mountain the writer measured a tree 95 feet high and 10 feet 10 inches in circumference at 4 feet above the ground.

Associated with Mountain Hemlock, Silver Pine and Red Fir, Weeping Spruce is a most remarkable species inhabiting the tops of mountain ranges lying in a country long scourged by fire. The trees are found only at the highest altitudes, usually at the heads of north cañons where even in July or September one may find a lingering snowbank which feeds their roots with water. The appearance of the trees is so singularly different from that of any other conifer that they cannot ever be mistaken and at once arrest the attention of the traveler.

4. **TSUGA** Carr. HEMLOCK.

Slender trees with nodding leading shoots. Leaves linear, 2-ranked by the twisting of the petioles or spreading all around the stem; resin canal 1. Petioles jointed with a woody base which persists after leaf fall as a small rough process, upwardly projecting and somewhat blended with the stem. Staminate catkins a subglobose pendulous cluster of stamens on a long stipe-like peduncle arising from axillary winter buds; pollen-sacs subglobose, tipped with a short spur or knob, their cells opening transversely. Ovulate catkins erect from terminal winter buds. Cones maturing in the first autumn, pendent; scales thin, longer than the bracts. Seeds with resin vesicles on the surface; seed-leaves 3 to 6.—Seven species, North America and Asia. (Tsuga, its Japanese name.)

Leaves in flat sprays; cones ½ to 1 inch long.....1. *T. heterophylla.*
Leaves spreading around stem; cones 1½ to 3 inches long.....
.....2. *T. mertensiana.*

Coast Hemlock.

1. TSUGA HETEROPHYLLA Sarg. *T. mertensiana* Carr. Fig. 58.

Leaves mostly spreading in 2 ranks, linear, flat, 3 to 8 lines long, ½ to 1 line wide, blunt at apex, green and with a median furrow above, pale and with a median ridge below, contracted at base into a short but distinct petiole; cones oblong or conical when closed, roundish when open, ½ to ¾ or 1 inch long, pendulous and solitary on the tips of the branchlets, borne in great numbers; scales longer than broad, roundish at apex, with entire edge; bracts about ⅙ the length of the scales, broadly triangular with truncate or obtuse summits; seeds light-brown,

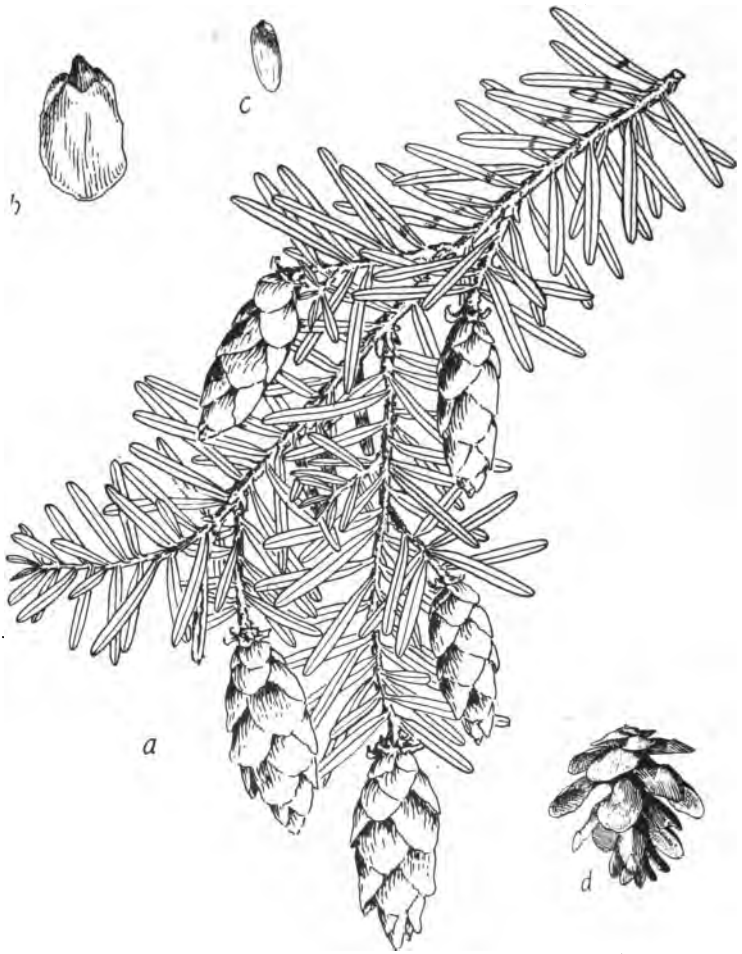

Fig. 58. Coast Hemlock (*Tsuga heterophylla* Sarg.). *a*, Cone-bearing branchlet; *b*, scale and bract; *c*, seed; *d*, open cone. nat. size.

1¼ line long with a wing 3 or 4 lines long and twice the breadth of the seed; seed-leaves 5.

Coast Hemlock, also called Western Hemlock, is a large but graceful forest tree 90 to 180 feet high, the trunk 1 to 4 feet in diameter and tapering gradually, the crown narrow or sometimes pyramidal. The branches are slender, with finely hairy branchlets, forming sprays which droop cascade-wise but not pendulous. The trunk bark is brown on the surface, dark red inside, shallowly fissured longitudinally or nearly smooth, ⅓ to ¾ inch thick. Sometimes one finds a tree in which the bark is twice as thick and deeply broken into small oblong plates one inch high, producing an irregularly warty appearance. The cones are borne more or less generally over the crown.

Tsuga heterophylla grows in the immediate vicinity of the coast from Elk Creek, Mendocino County, northward to Humboldt and Del Norte counties as a very subordinate associate of the Redwood, the trees usually occasional or scattered. Northward it ranges to Washington and Alaska where it is an important timber tree, and also eastward to the Cascades of Oregon and Washington and the mountains of northern Idaho and Montana.

The wood is fine-grained, yellow-brown, rather light and soft, works easily and is a valuable timber for many purposes. When manufactured into lumber it cannot, however, be sold

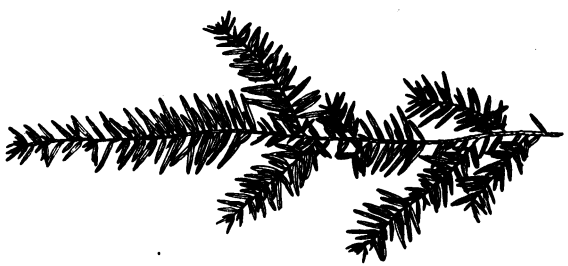

Fig. 59. Branchlet of Coast Hemlock. ⅓ nat. size.

on its merits under its own name on account of the popular prejudice against the name hemlock which is due in part to the many inferior qualities of the wood of Tsuga canadensis, the hemlock of the Eastern United States.

Mountain Hemlock.

2. TSUGA MERTENSIANA Sarg. *T. pattoniana* Senec. Figs. 60 and 3.

Leaves standing out all around the branchlet, cylindric or somewhat flattish above, strongly ridged below, glaucous on both surfaces, bluntish at apex, ¼ to ¾ (or 1) inch long, less than 1 line wide, with a distinct but short whitish petiole; cones red-brown, rich purple when young, cylindric but tapering to base and apex, 1½ to 3 inches long, ½ to ¾ inch thick; opened cones appearing more delicate, oblong in outline or tapering from base to apex, 1 to 1¼ inches in diameter; scales thin, rounded at apex, in the opened cone spreading at right angles to the axis or even recurving, their bracts about ⅓ as long, rounded above and tipped with a short point; seeds 2½ lines long, the wing 4 or 5 lines long; seed-leaves 4.

Mountain Hemlock, formerly called Williamson Spruce by some, and also Black Hemlock, is a graceful tree 20 to 90 feet high with conical trunks ½ to 2½ feet in diameter and bearing branches (except in dense forest) quite to the ground. The branches are slender, the lower ones long, forming a broad pyramidal base to the crown which is very promptly narrowed upward and ends in a long and narrow top. The branches above the base are horizontal or mostly drooping, the branchlets slender, pubescent and drooping. The cones are borne in the top of the tree, on drooping branchlets, sometimes forming heavy clusters.

Tsuga mertensiana, a timber-line tree, inhabits high slopes chiefly in protected situations at the heads of north or east cañons in moist places where snowbanks linger until early, or even late summer. It usually occurs in small pure somewhat open groves or clusters of limited extent. This subalpine type of tree, the most characteristic, retains its lowermost branches and is readily recognized by the habit of its crown, pyramidal at base but narrowed above, with drooping branchlets and pendulous whip-like leader. The crowns are usually dense throughout and sometimes remarkably slender above, presenting columns of foliage 15 to 30 feet high and sometimes not exceeding 2 feet in diameter except at the broad base.

In winters of heavy snowfall in the Sierra Nevada the heads of small saplings are bent over to the ground. Such deep snow does not always go off completely during the following summer but the position of these little trees may,

Fig. 60. MOUNTAIN HEMLOCK (*Tsuga mertensiana* Sarg.). *a*, Cone-bearing branchlet; *b*, scale and bract; *c*, seed. nat. size, the seed a little enlarged.

sometimes, be betrayed by the protrusion of a bow-like trunk through the surface of the drift.

At somewhat lower altitudes or in protected stations Mountain Hemlock forms large-sized forest trees either in pure stands or in association with Silver Pine, Red Fir or Tamrac Pine. A tree near the base of Mt. Lyell, measured

by the writer in 1909, was 80 feet high and 5½ feet in trunk diameter at 4 feet. On the east wall of Matterhorn Cañon is a pure stand of large-sized trees with trunks naked towards the ground, the branches horizontal in middle of crown and up to the tip. One tree measured 55 feet high and 5 feet in trunk diameter. It was typical of the larger sized trees throughout this fine grove.

Tsuga mertensiana is found in the Sierra Nevada between 8,000 to 11,000 feet at the south and 6,000 to 10,000 feet at the north. The southermost locality is on Bubbs Creek. Northward it is found on Glass Mountain, Goosenest Mountain and Mt. Shasta, thence west to Trinity Mountains, Marble Mountain, Klamath Range and the Siskiyous. Beyond our borders it ranges far north to Alaska and east to northern Montana.

5. **ABIES** Link. Fir.

Highly symmetrical trees of lofty stature, the branches in regular whorls and ramifying laterally, forming flat sprays. Leaves linear, flat, thickened or 4-angled, whitened beneath, spreading in 2 opposite directions or even 2-ranked, or more often curving upwards, leaving a smooth circular scar when they fall; resin canals in ours 2. Catkins from axillary winter buds. Staminate catkins borne on the under side of the branches, mostly in the upper half of the tree; pollen-sacs tipped with a knob, their cells opening transversely. Ovulate catkins erect, on the upper side of the topmost spreading branches. Cones erect, maturing in the first autumn, falling to pieces on the tree; scales thin, incurved at the broadened apex; bracts often exserted. Seeds with resin vesicles; seed-leaves 4 to 10. (The Latin name.)

Leaves of lower and uppermost branches slightly different.

Cones 2 to 5½ inches long; bracts not exserted.

Leaves glaucous or dull green, flat or on cone-bearing branches keeled above, acute or rarely notched at apex, spreading in two ranks or curving upwards, with a twist in the short petiole; old bark roughly and deeply furrowed, drab or grayish; high Sierra and Coast mts., chiefly 3,800 to 6,000 feet. .....1. *A. concolor.*

Leaves dark lustrous green, white beneath, notched at apex, usually spreading in two ranks, on cone-bearing branches often blunt, curving upwards; bark white, smooth or fissured into low flat ridges; north coast only.....2. *A. grandis.*

Cones 4 to 8 inches long, the bracts concealed or exserted; leaves thickened below and a little above so as to be subterete or somewhat 4-sided, thicker on the uppermost branches, curving upwards but not twisted, sessile; old bark deeply divided into roughly broken ridges, reddish brown; high Sierra and Coast mts., chiefly 6,000 to 9,000 feet .....3. *A. magnifica.*

Cones 4 to 5 inches long, the exserted bracts reflexed, usually concealing the scales; leaves of lower branches flattened, distinctly grooved above; Trinity Summit to Washington....4. *A. nobilis.*

Leaves alike all over tree; cones with conspicuous bracts, the exserted portion long and bristle-like; bark light brown, smoothish; Santa Lucia Mts. only.....5. *A. venusta.*

White Fir.

1. ABIES CONCOLOR Lindl. & Gord. Figs. 61 and 2.

Leaves ½ to 2½ (commonly 1 to 2 inches) long, flat, often with a median channel on upper side, or on the uppermost branches keeled, a prominent midrib beneath with a broad depressed stomatal band on either side, contracted at base into a very short twisted petiole, acutish, obtuse or slightly notched at summit, spreading in 2 ranks or more or less erect; cones brown, oblong, rounded at summit and base, 2 to 5½ inches long, 1¼ to 1¾ inches thick; scales broad and rounded; bracts nearly ½ as long as the scales, roundish and finely toothed, often with a notch at apex and usually terminating in a short slender point; seeds 5 lines long, the wing 6 or 7 lines long, widening towards the truncate apex, 5 or 6 lines wide; seed-leaves 6.

White Fir is a forest tree 60 to 150 or 200 feet high with a long narrow crown composed of flat sprays declined or spreading horizontally and a trunk 1 to 8 feet in diameter and clear of limbs for 30 to 100 feet. The trunk bark is smooth, silvery or whitish on young trees; on old trees it is 2 to 4 inches thick, broken into rounded ridges separated by heavy fissures, gray or drab-brown, in section showing dull-brown areas separated by a coarse light-colored mesh.

Abies concolor inhabits fertile mountain slopes, rocky ridges or plateaus or cañon walls. Associated with Yellow Pine, Sugar Pine and Incense Cedar it is one of the four most important forest trees in the main timber belt of the Sierra Nevada where it grows between 2,500 and 7,500 feet at the north and 5,000 to 8,000 feet at the south. In southern California it occurs on all the high cismontane ridges from Mt. Pinos south to the Sierra Madre (5,000 to 10,000 feet), San Bernardino Mountains (5,000 to 11,500 feet), Mt. San Jacinto (6,000 to 9,500 feet), Cuyamaca and Balkan mountains. It recurs on Mt. San Pedro Martir in Lower California.

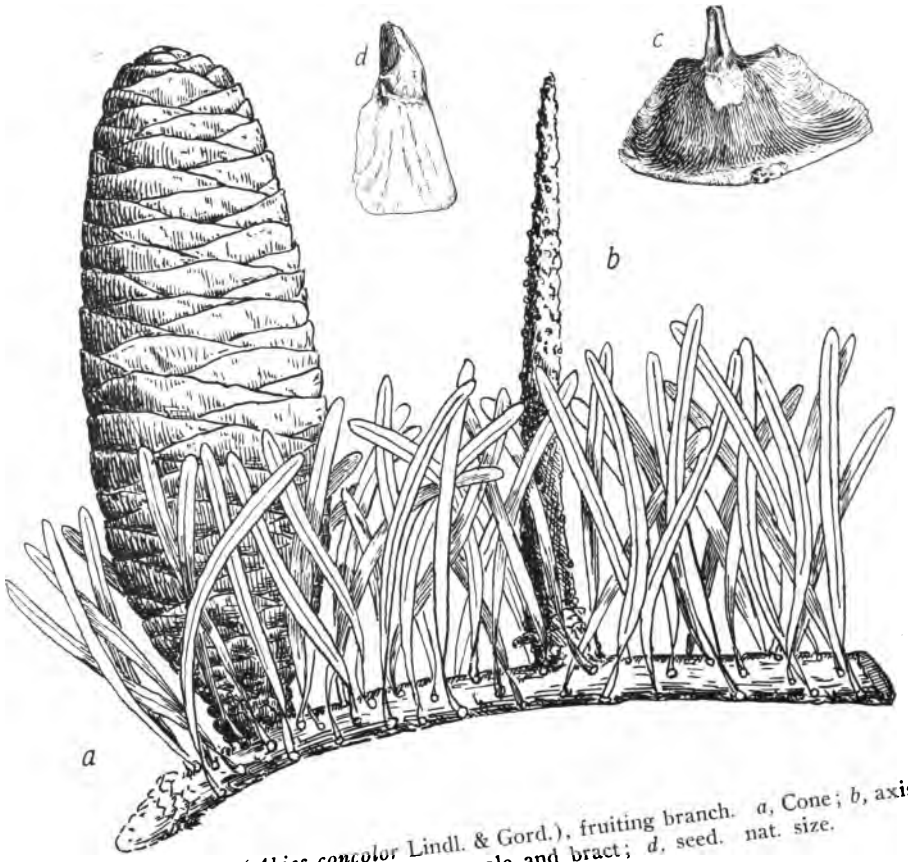

Fig. 61. WHITE FIR (*Abies concolor* Lindl. & Gord.), fruiting branch. *a*, Cone; *b*, axis from which scales have fallen; *c*, scale and bract; *d*, seed. nat. size.

White Fir is of rapid growth and aggressively reproductive since it will establish seedlings in its own territory wherever there is sufficient moisture. The wood is soft, light, coarse-grained, fairly strong and useful for timber but not used as yet to any great extent except as small lumber for fruit boxes. As a source of box lumber it is of particular importance to the California fruit industry.

Single individuals of exceptional size are often found on gentle mountain slopes or in cañon bottoms in deep soil. Near the upper end of Lake Merced (east of Yosemite) is a tree 160 feet high with trunk 8½ feet in diameter at 4½ feet above the ground. On the Cudahay trail to Dutch Henrys on the Klamath River the writer measured a tree 24 feet in circumference at 4 feet. These individuals of exceptional size which arrest the attention of the traveler are in most cases apparently of great age.

Lowland Fir.

2. ABIES GRANDIS Lindl.

Leaves flat, 1 to 2 inches long, notched at apex, dark lustrous green above and with a median channel, below with two white bands separated by a ridge; cones long-oblong in outline, 2½ to 4 inches long, 1½ to 1¾ inches thick; scales with a broad rounded summit and narrow stalk-like base, broader than long; bracts small, with a short awl-like point set on the roundish apex, ½ as long as the scales; seeds drab-color, 4½ lines long with a wing somewhat longer and twice as broad as the seed; seed-leaves 6.

Lowland Fir is a forest tree 40 to 160 or even 250 feet high with narrow conical crown of horizontal branches and trunks 1½ to 4 feet in diameter. The trunk bark is white or light brown, smooth or shallowly broken into low flat ridges; in section the inner bark is light brown, the outer dark red with a mesh of purple lines through it. The foliage is dark green and shining; on the lower horizontal branches the leaves spread by a twist at base in two opposite ranks and so make a flat spray, those originating on top of the stem having the peculiarity of being much shorter than those coming from the sides.

Abies grandis inhabits low hills or valleys and is distributed along the coast from northern Sonoma to southern British Columbia and western Montana. In California it is a very subordinate species. It is associated with Tideland

Spruce on the Mendocino bluffs and occurs as scattered trees among the dominant Redwoods to a distance of 15 or 20 miles from the coast, attaining its greatest size with us in the Redwood Belt of Del Norte County.

Its wood is light, soft, fairly strong and is milled in California on a small scale. The lumber is put to rough or temporary purposes. It rots very quickly in contact with soil but is held in local esteem along the north coast for shelving in dry goods stores and for similar purposes where an odorous wood is a desideratum.

Red Fir.

3. ABIES MAGNIFICA Murr. Figs. 62, 63 and 8.

Leaves ¾ to 1½ inches long, thickened below and a little above so as to be subterete or somewhat 4-sided, sessile by a thick foot, a little contracted above the foot, acutish at apex, those on the under side of the branches spreading right and left, those in the top of the tree more thickened, erect, incurved and hiding the upper side of the branch; cones 4 to 8 inches long, 2½ to 3½ inches thick, broadly oval or oblong in outline, the broad scales with upturned edges; bracts very variable in form and length, sometimes concealed beneath the scales, sometimes conspicuously exserted and reflexed, their terminal portion commonly transversely oblong, or broad with a short spreading awl-like point or pointless; seeds 7 lines long with a semi-fanshaped wing 7 to 8 lines long and 8 to 11 lines broad; seed-leaves 9 to 13.

Red Fir is a forest tree of great beauty 60 to 175 feet high with a narrowly conical crown composed of numerous horizontal or declined strata of fan-shaped sprays and a trunk 1½ to 5 feet in diameter. The bark on young trees is whitish or silvery, on old trunks dark red, very deeply and roughly fissured, in section showing reddish brown areas set off by a sharply defined purple mesh.

Abies magnifica grows on moist slopes or about swampy meadows, on rocky ridges, cliffs or granite plateaus. In the Sierra Nevada, where it attains its greatest development and is chiefly confined to the west slope, it is one of the more important species in the upper portion of the main timber belt, occurring mainly between 5,000 and 7,000 feet at the north and 6,000 and 8,500 feet at the south. It occurs as far south as the Greenhorn Range (south limits). Fine trees grow on the high plateaus in the Kaweah Peaks region. Perhaps the finest, most extensive and nearly pure forest of Red Fir covers Rancheria Mountain north of the Tuolumne

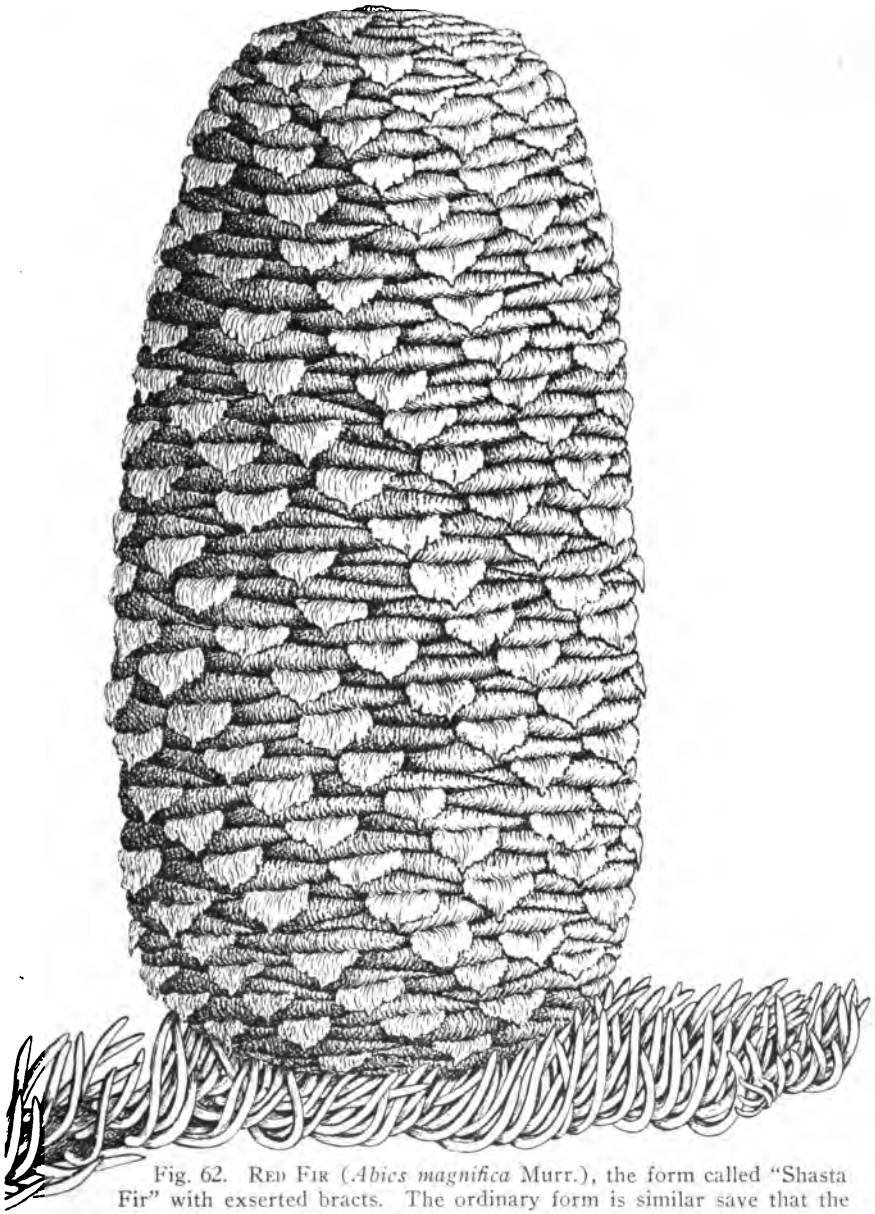

Fig. 62. Red Fir (*Abies magnifica* Murr.), the form called "Shasta Fir" with exserted bracts. The ordinary form is similar save that the bracts are concealed. nat. size.

River between Hetch-Hetchy and Matterhorn Cañon. It occurs on Grayback Mountain, Washoe County, Nevada, is abundant on Mt. Shasta, ranges west to Marble Mountain and the Trinity Mountains and south along the Yollo Bolly range to Snow Mountain in Lake County. Northward it extends into southern Oregon.

"Shasta Fir" is a form of the species with thicker and somewhat shorter cones and exserted bracts. It is not otherwise different, grows with the species on Mt. Shasta, and also in the North Coast Ranges and southern Sierra Nevada.

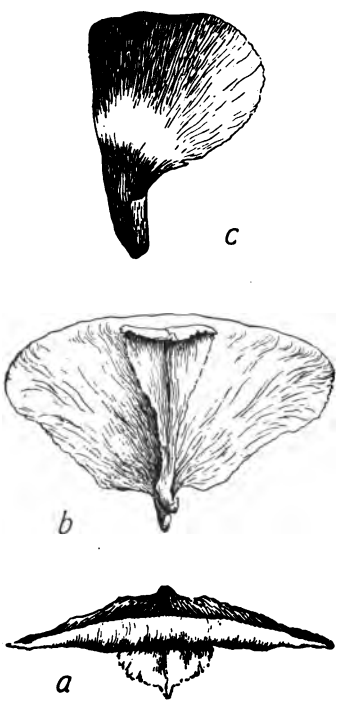

Fig. 63. The SHASTA FIR form of RED FIR. *a*, Scale and bract; *b*, scale and bract; *c*, seed. nat. size.

The wood of Red Fir is heavy, soft, strong, straight- and fine-grained and with a reddish tinge. On account of its durability and the large size of the saw logs it is valued in bridge building and for shaft timbers in the mines along the Mother Lode.

No other fir and indeed no other conifer of California equals this tree in the symmetrical beauty of its crown and its dark green stratified foliage. Trees of remarkable symmetry grow on protected slopes or in cañons where the moisture conditions are favorable. Beyond the borders of such habitats, especially at higher altitudes and on exposed granite ridges, grow isolated or scattered trees which have for the botanical traveler an equal interest on account of their wind-broken crowns and the irregularity of the resulting growths.

Noble Fir.

4. ABIES NOBILIS Lindl.

Leaves sharply and deeply grooved above, on the lower branches flat, on the upper branches rounded below or ridged and with two lateral shallow channels, erect, ¾ to 1½ inches long; cones oblong-cylindrical, 4 to 5 inches long, 2 to 2½ inches thick; scales surpassed and often wholly concealed by the reflexed spatulate bracts which are rounded, fimbriate and tipped with an awl-like point; seed-leaves 6 or 7.

Noble Fir is a forest tree 80 to 250 feet high with slender branchlets and roughly broken trunk bark. It is an important timber tree in the Coast Ranges and Cascades of Washington and Oregon, ranging south to and occurring sparingly on the Siskiyou Mountains of southern Oregon and Trinity Summit in California.

Santa Lucia Fir.

5. ABIES VENUSTA Koch. *A. bracteata* Nutt. Fig. 64.

Leaves stiff and sharp-pointed, dark green and nearly flat above, below with a white band on either side of the strong median ridge, 1¼ or mostly 1¾ to 2¼ inches long, 1 to 1½ lines wide, mostly 2-ranked; cones elliptic-oblong, 2½ to 4 inches long, 1½ to 2 inches thick, borne on peduncles ½ inch long which arise from a rosette-like cluster of broad thin scales of the winter bud; bracts wedge-shaped, truncate or notched at summit, the midrib prolonged into a long-exserted bristle ½ to 1¾ inches long and ½ line wide; seeds reddish brown, 3½ lines long with broad wings nearly as long and rounded at apex; seed-leaves 7.

The Santa Lucia Fir, often called Bristle-cone Fir, is a singular fir with a narrow crown abruptly tapering above into a steeple-like top. The trunk is ½ to 2½ feet in diameter, vested in light reddish brown bark and bearing short slender declined or drooping branches often nearly or quite to the ground. The cones, borne in heavy clusters in the top of the tree, are remarkable for the long bristles which protrude from between the scales.

Abies venusta grows in cañons or on sheltered slopes or sometimes on the summit of rocky ridges. It is confined to the Santa Lucia Mountains overhanging the Monterey coast and is known to occur in the following localities: Pine Cañon, headwaters of the Carmel River; Arroyo Seco near Tassajara Springs; Big Sur; near Santa Lucía Peak Trail; Twin Peaks; Cañada de los Potranchos; first cañon north of Los Potranchos; Bear Cañon near Punta Gorda; Villa Cañon; San Carpoforo Cañon; mountains near Cambria.

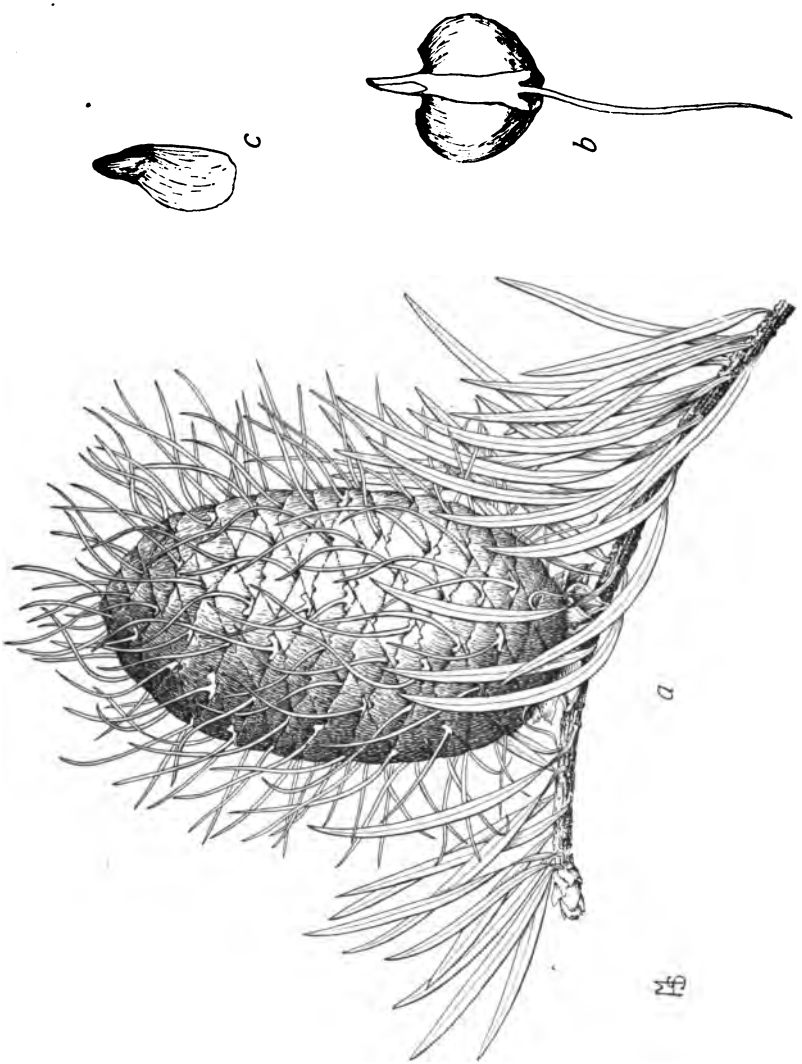

Fig. 64. Santa Lucia Fir (*Abies venusta* Koch.), remarkable for its long sharp-pointed leaves and long bristly bracts. *a*, Cone-bearing branchlet; *b*, scale and bract; *c*, seed. nat. size.

Santa Lucia Fir is the most remarkable fir tree in the world on account of its singular form, its sharp-pointed leaves alike all over the tree, its peculiar bristly cones, the small number of individuals and its restricted habitat. Moreover it is isolated geographically, no other species of fir being found within 225 miles to the north, 149 miles to the east and 120 miles northeasterly.

TAXODIACEAE. Redwood Family.

Trees with linear or awl-shaped alternate leaves. Staminate and ovulate catkins on the same tree. Staminate catkins small. Scales of the ovulate catkins spirally arranged, more or less blended with the bract, often spreading horizontally from the axis of the cone and developed into broad flattish summits. Ovules to each scale 2 to 9. Seeds not winged or merely margined.—Seven genera, widely scattered over the earth, each with 1 to 3 species. Taxodium (Bald Cypress), Cryptomeria (Japan Cedar), Cunninghamia, and Sciadopitys (Umbrella Pine) are cultivated in California.

1. SEQUOIA Endl. Redwood.

Tall trees with thick red fibrous bark and linear, awl-shaped, or scale-like leaves. Staminate catkins, terminal on the branchlets or on short lateral branchlets, with many spirally disposed stamens, each bearing 2 to 5 pollen-sacs. Ovulate catkins terminal, composed of many spirally arranged scales, each with 5 to 7 ovules at base. Cone woody, its scales divergent at right angles to the axis, widening upward and forming a broad rhomboidal wrinkled summit with a depressed center. Seeds flattened; seed-leaves 2 to 6. (The Cherokee chief, Sequoyah, who invented an alphabet for his tribe.)

Leaves awl-shaped, sessile, ascending all around stem; cones 2 to 3¼ inches long; Sierra Nevada only.....1. *S. gigantea.*
Leaves linear, petioled, spreading in 2 ranks and forming a flat spray; cones ⅝ to 1⅛ inches long; Coast Ranges only....2. *S. sempervirens.*

Big Tree.

1. Sequoia gigantea Dec. Figs. 65 and 35.

Leaves awl-shaped or lanceolate, 1 to 6 lines long, adherent below to the stem which they thickly clothe; cones maturing in second autumn, red-brown, ovoid, 2 to 3¼ inches long, composed of 35 to 40 scales;

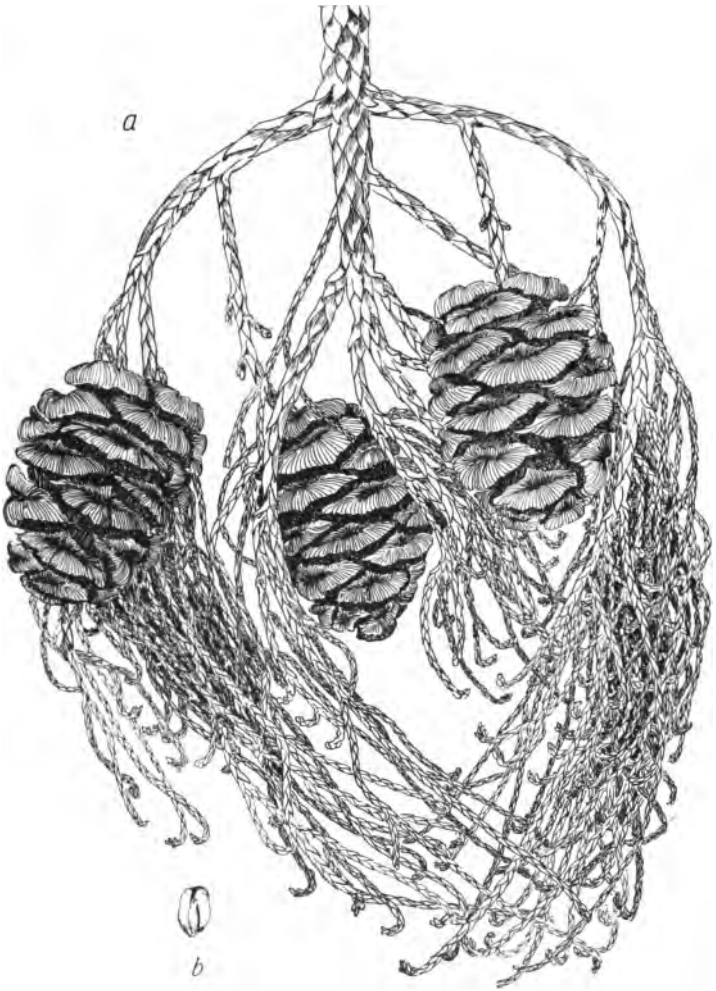

Fig. 65. BIG TREE (*Sequoia gigantea* Endl.). *a*, Cone-bearing branchlet, ⅔ nat. size; *b*, seed, nat. size.

scales with transversely rhomboidal summits and a centrally depressed umbo; seeds numerous, flattened, margined all around with a wing, ovatish or oblong in outline, 2½ to 3 lines long; seed-leaves 4 to 6.

Big Tree, the Wawona of the Mokelumne Tribe, is a remarkable giant tree 150 to 225 feet high with columnar trunks 80 to 180 feet to the first limb and 5 to 25 feet in diameter at 6 feet above the ground. The crown in young trees is a regular pyramid resting on the ground; in the adult tree it is narrow with rounded summit; in old age it is more or less broken, typically with dead axis projecting above it. The trunk is remarkably protected against fire by the fibrous red bark which is ½ to 2 feet thick and broken on the surface into heavy longitudinal ridges or fluted furrows.

Sequoia gigantea inhabits the western slope of the Sierra Nevada at 5,000 to 8,000 feet from Placer County southward to Tulare County, a longitudinal range of 250 miles but occurring in more or less widely disconnected and limited areas called "groves" thirty-two in number. The northern groves, that is, north of Kings River, are widely separated; the southern groves, south of Kings River, are less widely separated or even connected by scattered individuals and form an interrupted belt.

The northern groves are as follows: 1. North Grove, Placer County, 10 miles east of Michigan Bluff, 6 trees. 2. Calaveras Grove, 51 acres, 101 trees. 3. Stanislaus Grove, 6 miles southeast of Calaveras Grove, 1,000 acres, 1,380 trees. 4. Tuolumne Grove, on "Big Oak Flat"—Yosemite stage road, 1½ miles northwest of Crane Flat, 10 acres, 40 trees. 5. Merced Grove, on Coulterville-Yosemite wagon road, 3 miles from Hazel Green, 20 acres, 33 trees. 6. Mariposa Grove, in Yosemite National Park near Wawona, really consists of two groves, with 365 trees in upper grove and 180 trees in lower grove, one of the most famous being the "Grizzly Giant"; 125 acres. 7. Fresno Grove, in Madera County near north line, 2,500 acres, 1,500 trees. Many trees lumbered.

The southern groves are as follows: 8. Dinkey Grove, in Sierra National Forest, Fresno County, 50 acres, 170 trees. 9. Converse Basin Forest, Kings River, Fresno County, 5,000

acres, 12,000 trees; almost entirely lumbered. 10. Boulder Creek Forest, Kings River, Fresno County, 3,200 acres, 6,450 trees; more or less lumbered. 11. General Grant Forest, near Millwood, Fresno County, about 2,500 acres, 250 trees. 12. Redwood Cañon Forest, Redwood and Eshom creeks, Tulare County, 3,000 acres, 10,000 trees; more or less lumbered. 13. North Kaweah Forest, North Fork Kaweah River, 500 acres, 800 trees. 14. Swanee River Grove, on Swanee River branch of Marble Fork Kaweah River, 20 acres, 129 trees. 15. Giant Forest, Marble Fork Kaweah River, 8,000 acres, 20,000 trees, about 5,000 large ones. 16. Redwood Meadow Grove, Middle Fork Kaweah River, 50 acres, 200 trees. 17. Harmon Meadow Grove, Middle Fork Kaweah River, 10 acres, 80 trees. 18. Atwell Forest, both sides of East Fork Kaweah River, 3 miles west of Mineral King, 1,500 acres, 3,000 trees; in large part lumbered. 19. Lake Cañon Grove, East Fork Kaweah River, 20 acres, 80 trees. 20. Mule Gulch Grove, East Fork Kaweah River, 25 acres, 70 trees. 21. Homer Peak Forest, East Fork Kaweah River, 5,500 acres, 1,500 trees. 22. South Kaweah Forest, South Fork Kaweah River, 160 acres, 300 trees. 23. Dillon Forest, North Fork Tule River, 3,600 acres, 3,500 trees; large part lumbered. 24. Tule River Forest, Middle Fork Tule River, 15,000 acres, 5,000 trees; large part lumbered. 25. Pixley Grove, Middle Fork Tule River, 850 acres, 500 trees. 26. Fleitz Forest, Middle Fork Tule River, 4,000 acres, 1,500 trees. 27. Putnam Mill Forest, Middle Fork Tule River, 4,000 acres, 900 trees. 28. Kessing Grove, South Fork Tule River, 2,800 acres, 700 trees. 29. Indian Reservation Grove, South Fork Tule River, 1,500 acres, 350 trees. 30. Deer Creek Grove, South Fork Deer Creek, 300 acres, 100 trees. 31. Freeman Valley Forest, Kern River basin, 1,000 acres, 400 trees. 32. Kern River Groves, Kern River basin, 700 acres, 200 trees.

Big Tree prefers slopes, ridges or depressions where there is sufficient moisture but it may grow on bare granite as in the Giant Forest. It is commonly associated with White Fir, Incense Cedar, Yellow Pine and Sugar Pine. The reproduction is fair in the southern groves, especially on burned areas, but mostly at a standstill in northern groves. Young *trees have a pyra*midal outline with branches nearly or quite to

the ground; middle-aged trees are clear of branches for 50 to 175 feet and distinguished by a rounded summit to the crown; aged trees are characterized by a broken crown, dead tip to axis, and more or less shattered side branches.

The extreme age of Sequoia gigantea is 1,100 to 2,400 years so far as certainly known. The trees whose ages are certainly known are those which have been logged. When one considers that the oldest logged trees were seedlings five hundred years before the Christian era it would seem that such a lengthened period of life were sufficient to afford ample food to the reflective mind. But those popular writers, and eke the poets, whose figures are based solely upon an admiring contemplation of the bulk and stateliness of these forest giants are not satisfied with attributing to them ages less than 5,000 to 8,000 years.

The wood is dark red, but pink when freshly sawn, light and fairly strong. It is extraordinarily durable; posts last indefinitely and logs buried naturally, which must be centuries old, often show little or no decay in heartwood. Thousands of Big Trees on the Tule River, East Fork of the Kaweah, at the Fresno Grove, and especially in Converse Basin have been logged and manufactured into lumber which is used for the same purpose as Redwood. The mature wood is without resin-ducts which are always absent from the wood except in the first annual ring of new growth in adult (cone-bearing) trees.

The Big Trees are remarkable forest products. In stature they are imposing as no other living thing; in age they are a measure for the centuries; in situation they are stranded, after a long journey from the north, on the flanks of a mountain range where they are able neither to retreat nor to advance; in number they are comparatively few and are no more than holding their own ground; and in genealogy they are the direct descendants of a family dominant in the Tertiary period and richer then in genera and species than now.

On account of the unequalled character of the pines and firs in the Sierran forest the first sight of the Big Trees may be disappointing. But association with the Sequoias does much for man. As the days in their company run fleetly by, his appreciation continues to deepen and strengthen

until he instinctively senses something of the part they and their now wholly extinct congeners played in the Miocene epoch of the Tertiary.

Redwood.

2. SEQUOIA SEMPERVIRENS Endl. Figs. 66, 67, 12, 13, 14, 15, 16, 17, 18 and 19.

Leaves linear, spreading right and left so as to form flat sprays, ¼ to 1¼ (mostly ½ to ¾) inches long and 1 to 1¼ lines wide, or in the top of adult trees with short linear acuminate leaves 3 to 5 lines long, such branchlets strikingly suggestive of those of the Big Tree; cones oval, reddish brown, ⅝ to 1⅛ inches long and ⅝ to ⅞ inch thick, borne in clusters on the ends of branchlets mostly in the top of the tree, maturing in first autumn; scales 14 to 24; seeds narrowly margined, elliptic in outline, 2 lines long; seed-leaves usually 2.

Redwood is a tall and massive forest tree 100 to 340 feet in height with a rather narrow crown, the branches horizontal or sweeping downward, especially the lower ones. The trunk is 2 to 16 feet in diameter and protected by a red fibrous bark ¼ to 1 foot in thickness. The foliage is reddish brown.

Sequoia sempervirens* inhabits mountain slopes and valleys facing the sea and situated in the summer fog belt, and also ranges inland where it grows on protected slopes, cañon sides or valley floors. Geographically it is distributed from southwestern Oregon south to the Santa Lucia Mountains, embracing an area 450 miles long and 1 to 40 miles wide. The main body occurs in a well-defined belt which begins in Del Norte County and extends southward through Humboldt and Mendocino counties to southern Sonoma near Freestone, with a transverse break in the belt in southern Humboldt.

South of Sonoma County the Redwood occurs only in detached and irregular bodies as follows: Olema to Mt. Tamalpais and San Rafael in Marin County; Redwood Peak, Redwood Cañon and San Leandro Cañon in the Oakland Hills; Santa Cruz Mountains on both slopes from Palo Alto and Half Moon Bay to the south bank of the Pajaro River (the only station in San Benito County); Santa Lucia Mountains, only in deep

*Redwood was first described in 1803 by Lambert, an English botanist, who referred it to the genus Taxodium, naming it Taxodium sempervirens, that is the evergreen Taxodium to distinguish it from the deciduous *Taxodium distichum* or Bald Cypress. It was not until the year 1847 that Endlicher established the separate genus Sequoia for the Redwood, the *one* species known at that time, Sequoia sempervirens.

Fig. 66. REDWOOD (*Sequoia sempervirens* Endl.). *a*, Cone-bearing branchlet with usual type of foliage; *b*, seed. nat. size.

cañons on west slope of seaward range from Tobie Dow's ranch south to Salmon Creek Cañon.

Inland in the North Coast Ranges Redwood occurs very locally, ranging east to Willits, Walker Valley, Ukiah, Russian River at Cloverdale, Healdsburg, Sonoma Valley, west side of Napa Valley and east side of Howell Mountain in Napa Range, the latter being the station farthest from the ocean and the only station on the waters of a tributary of the Sacramento River.

In Mendocino, Redwood is associated with Douglas Fir, Tan Oak, Coast Hemlock and Lowland Fir. In Humboldt and Del Norte counties, where it attains its finest development, it occurs in almost pure stands, other species being very subordinate or absent. Magnificent bodies of Redwood, as yet untouched by the axe or only partially exploited, occur on the main Eel River, South Fork Eel River, Van Duzen River, Mad River, Redwood Creek, Lower Klamath River and Smith River.* The trees in these splendid forests are mostly mature or past maturity, 6 to 16 feet in diameter, 100 to 200 feet in height or taller, and yield 125,000 to 150,000 feet B. M. per acre. Limited areas have produced as high as 200,000 to 500,000 feet B. M. per acre and yields of 1½ million feet to the acre are on record. On hill slopes, as in Mendocino and Sonoma, the cut is about 20,000 to 50,000 feet to the acre.

The age of mature Redwood is 500 to 1,300 years. It has not in this matter been subject to so much imaginative controversy as has the Big Tree.

The wood is light, soft, straight-grained, free from resin, works easily, keeps its shape well and is subject to slight shrinkage or warping after initial seasoning. The autumnal part of the annual layer in the wood is thicker than in Big Tree which accounts for the greater strength and toughness of Redwood. It is used for a vast variety of purposes in house building, railway construction, bridges, telegraph poles, pipe lines and fences. It is marvelously durable in contact with soil. Other remarkable characteristics are that it ignites slowly, chiefly because wholly free from resin, and that on account of its spongy character it drinks up water from a fire hose with great avidity. California cities in which the buildings are largely constructed of Redwood

*Crescent City Indians regard the Redwood as occupying the centre *of the world.*

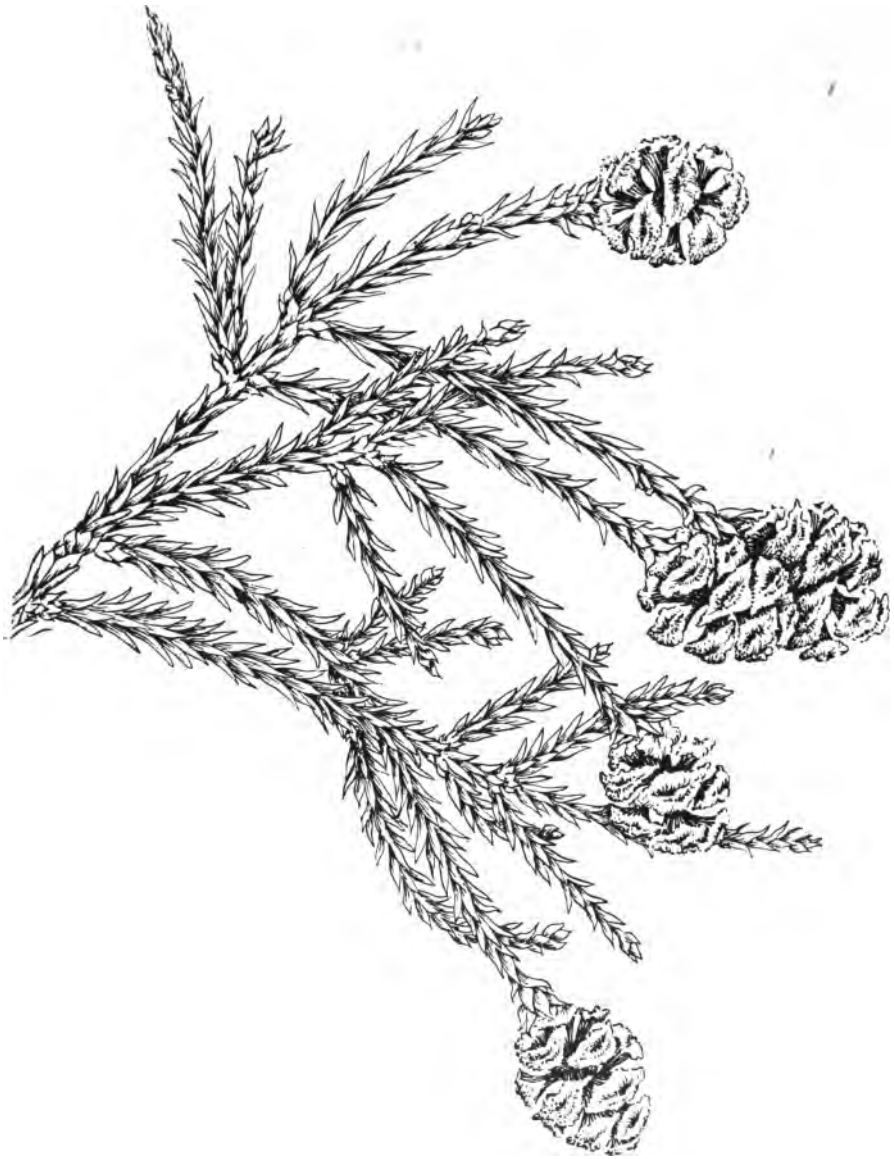

Fig. 67. REDWOOD (*Sequoia sempervirens* Endl.). Cone-bearing branchlet from summit of tree with leaves similar to those of Big Tree, nat. size.

are subject to a fire-control far superior to municipalities where resinous pine or fir prevails as building material. The old San Francisco, for instance, although a city in the main of frame Redwood houses, never had a destructive fire until 1906 when the water supply was completely shut off by earthquake disturbance.

One of the most emphatic tributes to the economic value of Redwood is that new uses are constantly being discovered for it. In certain water supply conduits in engineering projects it has replaced steel to the disadvantage of the latter. Redwood sawdust, hitherto treated as waste, is of possible importance in California horticulture for packing fresh grapes for Eastern shipment since it has qualities for this purpose which make it superior to ground cork which is used in Spain. Redwood doors have long had a good market in Central America because the wood is not eaten by white ants. Many more such instances might be given.

Redwood was first discovered in 1791 by Thaddeus Haenke, of the Malaspina Expedition, the first botanist to visit California. Archibald Menzies, a Scotch botanist attached to the Vancouver Expedition, visited the groves near Santa Cruz in 1792; it was from his specimens that Lambert in 1803 described the species as new.

The beauty of the Redwoods has been praised in prose by Miss Kate Field and countless other travellers and still further extolled by William Keith and other Californian artists in oils. The attractiveness and charm of the coast region is largely due to the presence of this tree. Tens of thousands of people from the cities go to the Redwood groves of Marin and Sonoma for three or four months of the rainless season, most commonly setting up their household gods in the shelter of the second-growth circles and living freely in the open air amongst the cinnamon columns and under a green forest canopy. Some stop on for the winter to learn the ways of the forest in the storm and to study the color hues which are but the playthings of wind and rain and sun.

The most delightful grove met by the author in all his travels north and south is situated between Usal and Cottonaby Creek on the Mendocino hills or bluffs overhanging the ocean two or three hundred feet at Turner's ranch. The tops of the trees

retain their original branches but the lower ones were long ago broken shortly off and in some cases replaced by tufts or brackets of foliage dependent from the stubs. These pendulous sprays are scattered and serve to ornament rather than conceal the red trunks. The setting of the trees is very fine; handsome and tall they stand on gentle knolls and in little swales, disposed in irregular clusters with bits of open between as if to reveal the quality of their finished shafts and the hues of their elegant foliage.

CUPRESSACEAE. CYPRESS FAMILY.

Trees or shrubs with opposite or whorled scale-like (or rarely linear) leaves thickly clothing the ultimate branchlets. Stamens and ovules in separate catkins. Staminate catkins terminal on the branchlets, small, with shield-like stamens bearing 2 to 6 pollen-sacs. Ovulate catkins consisting of several opposite or whorled scales which bear at base 1 to several erect ovules. Cones woody or in Juniperus fleshy, consisting of few "scales"; "scales" imbricated or shield-shaped, consisting morphologically of a completely blended scale and bract.—Nine genera, widely distributed over the earth. Thujopsis (Japanese Arbor-vitae) is in cultivation with us.

Branchlets flattened, disposed in one plane; leaves in 4 rows, the successive pairs unlike; cones maturing the first autumn, oblong, with overlapping scales; seeds 2 to each scale.

Cones pendent, scales 6, only the middle pair seed-bearing; seeds unequally 2-winged .....1. LIBOCEDRUS.

Cones reflexed, scales 8 to 12, the 2 or 3 middle pairs seed-bearing; seeds equally winged .....2. THUJA.

Branchlets cord-like; leaves in 3 or 4 rows; cones subglobose, their scales peltate (not overlapping).

Fruit a woody cone; stamens and ovules on same tree; leaves in 4 rows.

Cones maturing the first year; seeds winged, 2 to each scale.... .....3. CHAMAECYPARIS.

Cones maturing the second year; seeds acutely margined, many to each scale.....4. CUPRESSUS.

Fruit a berry, its seeds 1 to 3; stamens and ovules on different trees; leaves in whorls of 3 or opposite.....5. JUNIPERUS.

1. LIBOCEDRUS Endl. INCENSE CEDAR.

Aromatic tree with flattened branchlets disposed in one plane. Leaves scale-like, opposite, imbricated in 4 rows, the successive pairs unlike. Staminate and ovulate catkins term-

inal on separate branchlets. Staminate catkins with 12 to 16 decussately opposite stamens, each bearing 4 to 6 pollen-sacs. Ovulate catkin consisting of 6 scales with 2 ovules at the base of each. Cone maturing in first autumn, oblong, composed of 6 imbricated oblong scales, only the middle pair fertile. Seeds unequally 2-winged; seed-leaves 2.—Eight species, 1 on the Pacific Coast of North America, 2 in Chile and 5 in the region from southwestern China to New Zealand. (Greek libas, referring to the trickling of the resin, and kedros, cedar.)

Incense Cedar.

1. LIBOCEDRUS DECURRENS Torr. Figs. 68 and 2.

Leaves minute, 1 to 3 lines long, in four ranks and in opposite pairs, coherent, also adherent to the stem, free only at the tips, those above and below obtuse but minutely pointed and forming a pair overlapped by the

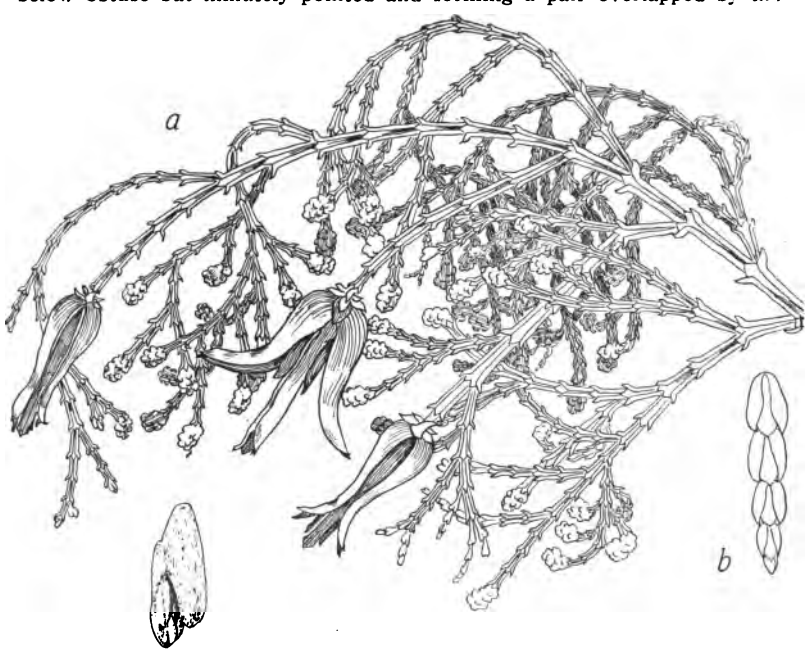

Fig. 68. INCENSE CEDAR (*Libocedrus decurrens* Torr.). *a*, Cone-bearing spray, nat. size; *b*, branchlet showing detail of leaves, 3 times nat. size; *c*, seed, 1½ times nat. size.

keel-shaped lateral pair; cones red-brown, oblong-ovate when closed, ¾ to 1 inch long, consisting of 2 seed-bearing (or fertile) scales with 3 (apparently 1) sterile scales between them and often with 2 supplementary ones at base; seed-bearing scales broad and flattish but not thin; all the scales with a small triangular umbo at tip; seeds 4 lines long, margined on each side from near the base to the apex by two very unequal wings; larger wing elliptical in outline and nearly as long as the seed.

Incense Cedar is a forest tree 50 to 125 feet high with an open irregular crown and trunk 2 to 7 feet in diameter at the base and tapering rapidly upward. The bark is 2 or 3 inches thick, red-brown or cinnamon, loose or fibrous in age, broken into prominent longitudinal furrows. The ultimate branchlets are numerous, alternate, forming flattish sprays and so clothed with adherent leaves as to appear jointed.

Libocedrus decurrens inhabits fertile mountain slopes, plateaus, valleys and borders of streams; it is less common on rocky ridges or gravelly bottoms. As an associate of Yellow Pine, Sugar Pine and White Fir, it is one of the four most abundant trees in the main timber belt of the Sierra Nevada and occurs chiefly between 2,000 and 5,000 feet at the north, 3,000 to 5,500 feet in the central part and 3,000 to 7,000 feet in the south. In the North Coast Ranges it occurs locally but generally in the high mountains east of the fog belt from Marble Mountain and Trinity Summit east to Mt. Shasta and ranges as far south as the neighborhood of Mt. St. Helena. In the South Coast Ranges it occurs on the Mt. Hamilton, Santa Lucia and San Carlos ranges. In Southern California it ranges from the San Rafael Mountains to the Sierra Madre, San Bernardino and San Jacinto mountains and south to Palomar and the Balkan and Cuyamaca mountains. Beyond our borders it extends into southern Oregon, western Nevada and Lower California.

Its wood is pale and reddish-brown, soft, light, fine and straight-grained. It is exceedingly durable either in contact with soil or water and meets the local requirements for posts and telephone poles.

2. **THUJA** L. ARBOR-VITAE.

Aromatic trees with scattered branches and flattened branchlets disposed in one plane. Leaves minute, scale-like, opposite and imbricated in 4 rows, the successive pairs unlike,

adnate to the stem but with free tips. Catkins terminal. Staminate catkins with 4 to 6 stamens, each with 3 or 4 pollen-sacs under the subpeltate crests. Ovulate catkins with 8 to 12 erect scales, each with 2 erect ovules at base. Cones small, maturing in first autumn, reflexed; scales 8 to 12, thin-leathery, the lowest and uppermost pairs sterile. Seed bordered by nearly equal lateral wings so as to be nearly round; seed-leaves 2. — Four species, 2 in North America, and 2 in China and Japan. (Name of some tree known to the Greeks.)

Canoe Cedar.

1. THUJA PLICATA Don. Fig. 69.

Leaves minute, closely imbricated in 4 ranks (in opposite pairs and concealing the stem), of 2 kinds, those on the margin of the flat sprays keeled or somewhat boat-shaped and acute at tip, those above and below flattish and triangular at apex; cones borne on short lateral branchlets, on opening turned downward beneath the spray, cinnamon-color, oblong in outline when closed, and ½ inch long; scales 9, the outer ones oblong or obovate, and much broader than the narrow inner ones; seeds winged all around but with a narrow notch at apex, the whole structure 3 lines long.

Canoe Cedar is usually a giant tree 75 to 200 feet high with pyramidal or roundish crown, the branches long, the branchlets slender and drooping. The trunk is enormously swollen at the base, giving diameters of 4 to 16 feet at the ground but at ten feet above diminishing so rapidly as to be only about one-half the diameter at the ground. The cinnamon bark is very thin, only ½ to 1 inch thick. The branchlets are repeatedly 2-ranked, forming flat sprays thickly clothed with minute leaves.

Thuja plicata inhabits moist slopes or especially gulches, flats or river bottoms. It ranges from the Bear River Mountains in Humboldt County northward to southeastern Alaska and is abundant and of great size on the Oregon and Washington coasts. In California the trees are small and grow in a few localities of limited extent.

The wood is highly aromatic, reddish brown, light and soft. Its most remarkable quality is durability which in connection with the size of the clear logs makes it especially suitable for manufacture into shingles for which it is extensively used. The Indians of the Northwest Coast hewed their long war canoes out of a single log, wove the fibrous

Fig. 69. CANOE CEDAR (*Thuja plicata* Don). *a*, Cone-bearing spray, nat. size; *b*, winged seed, 1¼ times nat. size.

bark into clothing and mats, and made dwelling and household utensils out of the wood.

3. CHAMAECYPARIS Spach.

Trees or shrubs; leading shoot nodding; branchlets more or less flattened and in flat sprays; leaves opposite, in 4 rows, the successive pairs in ours unlike. Catkins and cones very similar to Cupressus. Stamens with usually 2 pollen-sacs. Ovules 2 to 5 at the base of each scale, the seeds winged, usually 2 (1 to 5). Cones maturing in the first autumn, their scales shield-shaped. Seed-leaves 2.—Six species, 3 in North America and 3 in Japan. (Greek chamai, on the ground, and kyparissos, cypress.)

Port Orford Cedar.

1. CHAMAECYPARIS LAWSONIANA Murr.

Leaves minute, adpressed, scale-like, thickly clothing the branchlets, disposed in opposite pairs, those above and below rhomboidal, glandular-pitted and overlapped by the keel-shaped ones on the margin; staminate catkins crimson; ovulate catkins consisting of about 7 scales, maturing in the first autumn into globose cones 3 to 4 lines long; seeds 1½ to 2 lines long, narrowly wing-margined on each edge, the whole structure orbicular.

Port Orford Cedar, the Lawson Cypress of the gardens, is a forest tree 80 to 175 feet high with narrow crown and horizontal or drooping branches ending in broad flat drooping fern-like sprays. The trunk has a tall straight shaft, its bark brown or somewhat reddish, smooth on young trees, later parting on the surface into large loose thin shreds and finally in adult trees fissured longitudinally with the furrows continuous and separated by flat ridges.

Chamaecyparis lawsoniana inhabits sandy ridges near the coast, moist slopes in the mountains or the bottoms of cool cañons or gulches. It reaches its best development on the west slope of the Oregon Coast Range between Coos Bay and Rogue River within 3 to 15 miles of the ocean. It ranges south to Mad River, Humboldt County, California and eastward to the Sacramento River Cañon. In California its localities are few; it occurs on Three Creeks and doubtless at other places in the range between Hupa Valley and Redwood Creek; Hall's Gulch and near Trinity Center in Trinity County; east slope of Klamath Range on Cottage

Grove Trail at Willis Hole and at Onion Patch a few miles west; Quartz Creek (fine trees 150 feet high) and Shelley Creek (Del Norte County). It also occurs on both forks of the Illinois River in Oregon.

Its wood is aromatic, yellowish white, light, fine-grained, hard and strong. It is very durable, works easily, takes a very superior finish and is highly valued for cabinet work. Forestrally the tree is very valuable but the area in which it occurs in commercial quantity is so restricted that the supply of this timber can be depended upon to last but a very limited time.

4. CUPRESSUS L. CYPRESS.

Trees or shrubs. Leaves scale-like, small, appressed, closely imbricated in four ranks on the ultimate cord-like branchlets, or awl-shaped on vigorous shoots. Staminate catkins terminal on the branchlets with 3 to 5 pollen-sacs to each stamen. Ovulate catkins on short lateral branchlets, the ovules numerous, erect, in several rows at the base of the scales. Cones globose to oblong, maturing in the second year, the shield-shaped scales fitting closely together by their margins, not overlapping, separating at maturity, their broad summits with a central boss or short point. Seeds acutely angled or margined; seed-leaves 2 to 5.—North temperate, about 14 species. (Classical name of the Cypress.)

Umbos low, crescent-shaped, upwardly impressed.
- Glands on leaves none or rare; maritime species.
  - Seed small, black; branchlets squarish.....1. *C. goveniana.*
  - Seed larger, brown; branchlets terete.....2. *C. macrocarpa.*
- Glands on leaves present as a closed dorsal pit; seeds brown; Coast Ranges.....3. *C. sargentii.*

Umbos conical, well-developed, spreading; leaves with a conspicuous resin pit.
- Cones red-brown, 5 to 8 lines long; umbos typically incurved; North Coast Ranges and northern Sierra Nevada....4. *C. macnabiana.*
- Cones silvery or glaucous, 5 to 6 lines long; umbos short conical; lava beds.....5. *C. bakeri.*

Gowen Cypress.

1. CUPRESSUS GOVENIANA Gord. Fig. 70b, c.

Branchlets very slender, squarish; leaves without pits, rarely with lateral depressions; cones light brown, subglobose or oval, 6 to 8 lines long, rarely longer, with 4 pairs of scales; umbo short, crescent-like, thin-

edged; seeds black, angular or acutely margined, sometimes minutely warty, 1 to 1½ lines long.

The Gowen Cypress is a small shrub 1 to 20 feet high. It rarely becomes a tree 75 feet high with the trunk bark brown, smoothish, but superficially checked into freely interlocking ribbons ¾ inch broad. It grows at Monterey on the west slope of Huckleberry Hill associated with Bishop Pine, and on the Mendocino coast from Fort Bragg to Mendocino City. In the latter region it is locally abundant on the Mendocino "White Plains," a low alkaline plateau lying one or two miles back of the ocean shore. It occurs on these plains in four forms: 1. Most abundantly as freely branching shrubs 6 to 15 feet high. 2. Scarcely less abundantly as canelike dwarfs 1 to 3 feet high, with unbranched axis and only a few short branchlets; these miniature trees fruit very heavily and form one of the interesting features of the peculiar woody flora of the region. 3. As slender poles; only a few feet away from the dwarfs just mentioned, where the soil and moisture change slightly, slender poles 15 to 25 feet high were found by the writer crowded in a limited space. 4. As timber trees; two miles back of Ft. Bragg I found in a miniature swale of the plain two trees 75 feet high with clean trunks 30 and 40 feet high and 2 feet 10 inches and 2 feet 8 inches in diameter respectively at 4 feet above the ground.

Monterey Cypress.

2. CUPRESSUS MACROCARPA Hartw. Fig. 70a.

Branchlets thicker than in last, terete, densely clothed with triangular scale-like leaves; leaves ½ to 1½ lines long; cones dull brown, broadly oblong or subglobose, 1 to 2 inches long; scales about 7 pairs, flat-topped, with a central curved thin-edged ridge-like (or sometimes subconical) umbo; seeds brown, 1 to 2 lines long, narrowly wing-margined but irregularly shaped from crowding in the cone and with a minute white lanceolate attachment scar at base.

Monterey Cypress is a tree 15 to 80 feet high. Its crown in protected situations is broadly conical with spreading finger-like tips to the main branches. Trees standing on the cliffs or exposed directly to the ocean exhibit much flattened or irregularly broken crowns and strongly flattened or board-like trunks or main branches. The trees often show great differences in size and shape of cones and development of

umbos but such variations may sometimes be found on one individual.

Cupressus macrocarpa is limited to two localities on the ocean shore at the mouth of the Carmel River near Monterey. The Cypress Point Grove extends along the cliffs and low bluffs from Pescadero Point to Cypress Point, a distance of two miles, reaching inland about one-eighth of a

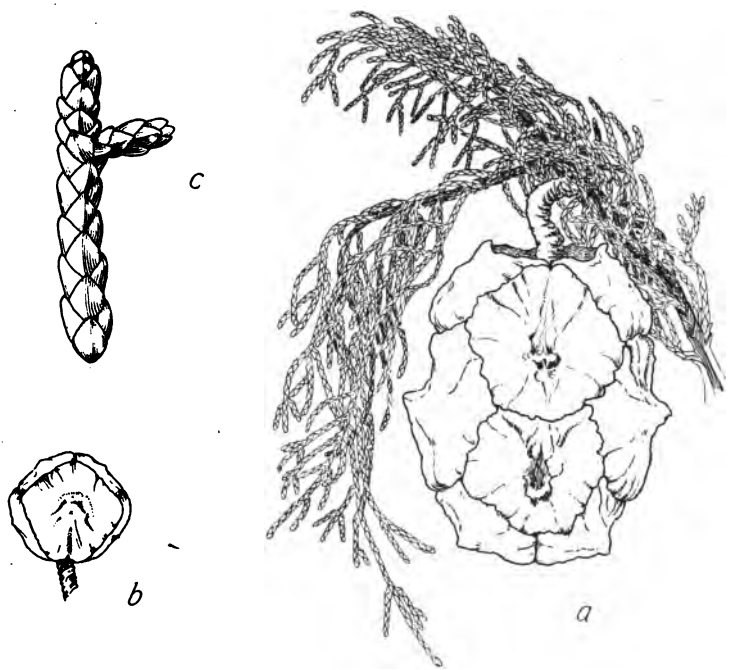

Fig. 70. *a,* MONTEREY CYPRESS (*Cupressus macrocarpa* Hartw.); cone-bearing branchlet, nat. size. *b,* GOWEN CYPRESS (*Cupressus goveniana* Gord.), cone, nat. size; *c,* squarish branchlet, 8 times nat. size.

mile. The Point Lobos Grove is much smaller. The trees are scattered over the summits of two headlands and cling to the edges of the cliffs, where on account of the erosive action of the ocean they are occasionally undermined and fall into the sea.

Monterey Cypress is most interesting for its remarkably restricted natural range and the exceedingly picturesque outlines characteristic of the trees growing on the ocean shore. As a result of their struggle with the violent storms from the Pacific Ocean which break on the unprotected cliffs and headlands of Cypress Point and Point Lobos, they present a variety and singularity of form which is obviously connected with their exposed habitat and lends a never-failing interest to these two narrow localities.

Of the highly picturesque trees, the most common type is that with long irregular arms. Such trees recall most strikingly the classical pictures of the Cedars of Lebanon. Monterey Cypress is of course a genuine cypress and Lebanon Cedar a genuine cedar; the two do not even belong to the same family of conifers. Yet the popular story that the two are the same makes so strong an appeal to the imagination of the tourist at Monterey that the guides and promoters in the region will doubtless never cease to disseminate it. As a consequence the error goes into the daily press and the magazines and is evidently destined to flourish in perennial greenness under the guise of fact. The wide dissemination of this fiction is all the more remarkable in that in the case of all other unique features of the State, such as the Sequoias and the Yosemites, our Californians have evinced a remarkable pride in their possession without thought of inventing a duplication of them elsewhere.

Although so local a species in its natural habitat, Monterey Cypress takes most kindly to cultivation and to horticultural methods. It is widely cultivated in California for ornament, for wind-breaks and for hedges. While long-lived in coast gardens, trees planted in the dry interior valleys rarely live more than twenty-five years. As a cultivated tree Monterey Cypress has also been planted in various parts of Europe and also with especial success in Australia and New Zealand.

Sargent Cypress.

3. CUPRESSUS SARGENTII Jepson. Fig. 71b.

Branchlets thickish; leaves with a closed dorsal pit, rarely with lateral depressions, about ½ line long; cones globose, often congested in heavy clusters, shortly peduncled, 8 to 10 lines in diameter; scales

6 or 8; umbo a very small low thin-edged crescent, sometimes prominent and somewhat conical; seeds brown, acutely margined, 1½ to 2 lines long.

The Sargent Cypress is a shrub or small tree 8 to 15 or rarely 60 feet high with grayish brown fibrous bark. It grows on mountain slopes and is distributed from Red Mountain (southern Mendocino) to Mt. Tamalpais, and southward to Cedar Mountain (southeastern Alameda County), Santa Cruz and Santa Lucia mountains. Altitudinally it occurs chiefly between 2,000 and 2,300 feet.

The tree or shrub of the San Diego mountains, heretofore referred to this species by authors, is determined by my student, Mr. C. N. Forbes, to be the Guadalupe Cypress (Cupressus guadalupensis Watson).

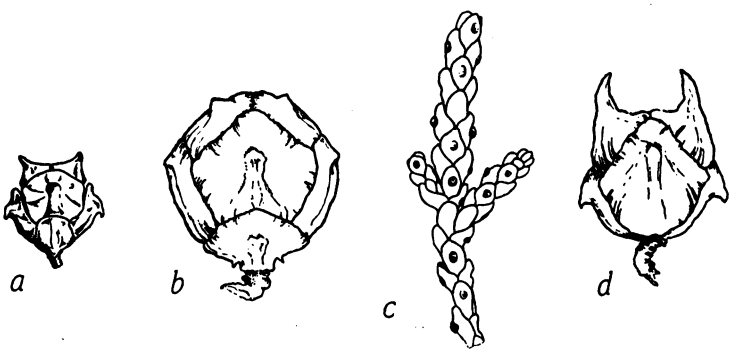

Fig. 71. *a,* MODOC CYPRESS (*Cupressus bakeri* Jepson), cone, nat. size. *b,* SARGENT CYPRESS (*Cupressus sargentii* Jepson), cone, nat. size. *c,* MACNAB CYPRESS (*Cupressus macnabiana* Murr.), branchlet showing glandular pits on back of leaves, 6 times nat. size; *d,* cone of MACNAB CYPRESS, nat. size.

MacNab Cypress.

4. CUPRESSUS MACNABIANA Murr. Fig. 71c, d.

Branchlets very slender; leaves ½ line long with a conspicuous resin pit or white gland on the back towards the apex, often slightly glaucous; cones globose, clustered, short-peduncled, 5 to 8 lines in diameter, reddish or grayish brown; scales 6 to 8 with strong conical umbos, the uppermost very prominent or horn-like and incurved; seeds brown, 1½ to mostly 2 lines long.

MacNab Cypress is a shrub or small bushy tree 5 to 25 or sometimes 40 feet high with trunk ¼ to nearly 2 feet in diameter. The trunk bark is light gray and very smooth.

Cupressus macnabiana inhabits dry hills or flats. It is distributed from Samuels Springs (central Napa county) and Mt. Aetna to the northeast side of Mt. St. Helena and Red Mountain; from Bartlett Creek north to the vicinity of Whiskeytown, Shasta County; and in the northern Sierra foothills. It is readily distinguished by the highly pungent and somewhat aromatic odor of the foliage, by its blue-green crowns, and by the prominent horn-like crests on the summit of the cones.

Modoc Cypress.

5. CUPRESSUS BAKERI Jepson. Fig. 71a.

Leaves with a distinct resin pit on middle of keeled back; staminate catkins 1 line long or less; cones globose, satiny or glaucous, 5 to 6 lines in diameter; scales 3 pairs or with a fourth smaller upper pair; umbos abruptly drawn to a short point, either nipple-like or compressed, straight or slightly curved; seeds brown, 1½ lines long, narrowly wing-margined.

Modoc Cypress is a shrub 6 to 10 feet high or becoming a small tree up to 25 feet. The bark is red-brown and the branchlets very slender. It grows on the lava beds of southeastern Siskiyou and southwestern Modoc at 4,000 feet altitude where it occurs in association with scrub Yellow Pine, Knob-cone Pine and Sierra Juniper.

5. JUNIPERUS L. JUNIPER.

Trees or shrubs. Leaves in whorls of 3 or opposite, scale-like, imbricated, closely appressed and adnate to the branchlets, or linear-subulate and spreading. Stamens and ovules on separate trees. Staminate catkins with many stamens, each with 2 to 6 pollen-sacs. Ovulate catkins of 3 to 6 succulent coalescent scales, each bearing 1 or 2 ovules. Cones fleshy and berry-like, ripe in the second year, in ours 1 to 3-seeded; seed-leaves 2 to 6.—Northern hemisphere, about 30 species. (Ancient Latin name.)

Catkins axillary; leaves linear-subulate, spreading, white-glaucous above; subalpine shrub ..... 1. *J. communis.*

Catkins terminal on short branchlets; leaves scale-like, closely appressed to the branchlets, in whorls of 3 or opposite.

Berries reddish brown, oblong; seed-leaves 4 to 6; medium altitudes ..... 2. *J. californica.*

Berries blue-black, globose or subglobose.

Seed-leaves 4 to 6; desert ranges..... 3. *J. utahensis.*

Seed-leaves 2; high Sierra Nevada ..... 4. *J. occidentalis.*

1. **Juniperus communis** L. var. **montana** Ait. DWARF JUNIPER. Low or prostrate shrub, 1 foot high or less, forming patches a few feet in diameter; leaves rigid, linear or lanceolate, acute, cuspidate, 3 to 6 lines long, 3 (rarely 2) at a node with very short internodes, spreading or ascending, green below, white-glaucous above; berries bright blue, globose, covered with white bloom, 1½ to 2½ lines long.—Sierra Nevada, 8,000 to 9,500 feet, from Mono Pass and Desolation Valley near Lake Tahoe to Mt. Shasta, thence westward to Del Norte County. Few stations known in California. It occurs in the Rocky Mountains, ranges north to Alaska, thence around the earth in arctic and subarctic regions. In the Eastern United States the species takes on an erect shrub form or even occurs as a small tree.

California Juniper.

2. JUNIPERUS CALIFORNICA Carr.

Leaves in 3s, ovate, acute, each with a dorsal pit towards the base, crowded on the ultimate branchlets or occasionally free and subulate, ½ to 1 line long; berries reddish or brownish, almost smooth or roughened with a few small projections or horn-like processes, covered with a dense white bloom, subglobose or oblong, 4 to 7 lines long, with dry fibrous sweet flesh and 1 to 3 seeds; seeds ovate, acute, brown, with a thick smooth but angled or ridged polished bony shell, 3 to 5½ lines long; embryo 2⅓ lines long with 4 to 6 seed-leaves.

The California Juniper is a bushy shrub 2 to 15 feet high, or sometimes a tree up to 25 feet high. The bark is ashen gray or brown, the thin outer layers becoming very loose and shreddy. It inhabits arid or desert foothills and is most abundant on the western Mohave Desert, particularly on the desert slopes of the San Bernardino, Sierra Madre, Sierra Liebre and Tehachapi mountains. Thence it ranges westward to the San Rafael Mountains and northward it is scattered at intervals along the inner Coast Range as far north as Mt. Diablo. Southward it is found along both slopes of the San Jacinto Range into Lower California, and extends northward in the Sierra Nevada to Kern River Valley as far as Kernville. It is local near Coulterville in Mariposa County. In the North Coast Ranges it occurs on the eastern slope of the Yollo Bolly Range from the foothills at the easterly base of Snow Mountain westward to the mountains about Bachelor Valley and eastern foothills of the Mayacamas Range in western Lake County. It does not occur in the "Lower Sacramento" country as so often stated in the books.

Desert Juniper.

3. JUNIPERUS UTAHENSIS Lemm.

Leaves acute, in whorls of 3, sometimes opposite; berries usually globose, blue-black, with a whitish bloom and 4 to 5 lines long, resembling those of the Sierra Juniper but the seed-leaves 4 to 6.

Desert Juniper is a small or stunted shrub 3 to 10 feet high or rarely a tree up to 20 feet high. It is very similar to the California Juniper but distinguishable by its more slender branches, usually glandless leaves and globose berries. It inhabits the desert ranges east of the Sierra Nevada (White, Inyo, Panamint, Providence and Grapevine mountains), and ranges through Nevada to the central Rocky Mountains and to northern Arizona. Its wood is hard, fine-grained and exceedingly durable. In the sparingly wooded regions where this tree grows it is, like the California Juniper, an important resource to settlers for fence posts and fuel.

Sierra Juniper.

4. JUNIPERUS OCCIDENTALIS Hook.

Leaves in 3s, ½ line long, ovate-triangular, bearing on the back a more or less distinct gland or pit, or on vigorous shoots subulate and 1 to 2 lines long; staminate catkins 1½ to 2 lines long, 6 pollen-sacs under each peltate scale; berries globose to ovoid, blue-black with a whitish bloom, 3 to 5 lines long, almost smooth or minutely umbonate with resinous juicy flesh and 2 seeds (rarely 1 or 3); seeds flat on the face, the convex back with 3 to 5 resinous-glandular pits; embryo ¾ to 1 line long, with 2 seed-leaves.

Sierra Juniper is a sub-alpine tree 10 to 25 or sometimes 65 feet high with trunk 1 to 5 feet in diameter. It inhabits the Sierra Nevada, where it reaches its best development, and is a timber line tree at altitudes of 9,000 to 10,500 at the south and 7,000 to 9,000 feet at the north. It also occurs at a few stations in the Yollo Bolly Range, San Bernardino Mountains and Panamint Range. Northward it extends through eastern Oregon and Washington to Idaho.

The crown, which is a full and rather regular cone, is replaced by much broken or deformed tops wherever the trees grow in exposed situations. Since a favored habitat is high wind-swept granite plateaus or ridges, highly irregular or even prostrate crowns are a very characteristic feature of the sub-alpine region of the Sierra Nevada.

At lower altitudes in the same range Sierra Juniper is often a very conspicuous figure on granite tables, shelves and ledges of cañon walls or cliffs where it sometimes grows to great size, trunks 4 to 6 feet in diameter not being uncommon.

TAXACEAE. YEW FAMILY.

Trees or shrubs with linear leaves 2-ranked by a twist in their petioles. Stamens and ovules borne on different trees and appearing in early spring from axillary scaly winter buds. Stamens united by their filaments into a column with 4 to 8 pollen-sacs pendent from each filament. Ovule solitary, terminal on a short axillary branch. Seeds set loosely in a fleshy cup, or quite enveloped by it and thus appearing drupe-like, ripe in first autumn; seed-leaves 2.—Eight genera, northern and southern hemispheres.

Fruit red, berry-like; leaves ½ to ⅔ inch long, acute.....1. TAXUS.
Fruit green or purplish, plum-like; leaves 1¼ to 2½ inches long, stiffish, bristle-pointed .....2. TORREYA.

TAXUS L. YEW.

Trees or shrubs, the leaves bluntish or merely acute. Stamens 7 to 12 in a cluster, the 4 to 9 pollen-sacs borne under a shield-like crest. Ovule seated upon a circular disk which in fruit becomes cup-shaped, fleshy and red, surrounding the bony seed, the whole berry-like. Seed-leaves 2.—Northern hemisphere, 1 species and 6 subspecies. (Ancient Latin name of the yew, probably from Greek toxon, a bow, the wood used for bows.)

Western Yew.

1. TAXUS BREVIFOLIA Nutt. Fig. 72.

Leaves linear, acute at apex, shortly petioled, flat, with midrib in relief above and below, 3 or mostly 6 to 8 lines long, 1 line wide, spreading right and left in flat sprays; seeds borne on the under side of the sprays and when mature set in a fleshy scarlet cup, the whole looking like a brilliantly colored berry.

Western Yew is a small tree 10 to 30 or rarely 50 feet high with an irregular crown, the branches of unequal length and standing at various angles but tending to droop. The trunk is ½ to 2 feet in diameter with a thin red-brown smooth bark which is superficially deciduous in small thin shreds.

Taxus brevifolia inhabits deep cool shady cañons or stream-bottoms. The localities in California are comparatively

Fig. 72. WESTERN YEW (*Taxus brevifolia* Nutt.). *a*, Fruiting branchlet, nat. size; *b*, longitudinal section of "berry," 1½ times nat. size.

few and rather widely separated. In the Coast Ranges it occurs in the Santa Cruz Mountains, on Mt. St. Helena, at various stations in Mendocino and Humboldt counties, on Marble Mountain and thence east to the Sacramento River cañon. In the Sierra Nevada it occurs from Lassen Peak southward to Tulare County.

The wood of Western Yew is very fine and close-grained, very hard and heavy, flexible and remarkably durable. It is used by mechanics for tool handles and machine bearings and by the native tribes for their best bows. Yew logs, buried in the alluvial benches of the Eel River doubtless for several centuries, have been excavated and used by rural artisans for wedges and pulleys and by the settlers for mauls and gate-posts.

TORREYA Arn. STINKING YEW.

Trees with rigid sharp-pointed leaves in 2 ranks. Stamen clusters solitary in the adjacent leaf axils, borne on 1-year-old branches, made up of 6 to 8 whorls of stamens, 4 stamens in a whorl, each filament with 4 pollen-sacs without crests. Ovule completely covered by a fleshy aril-like coat, the whole becoming drupe-like in fruit. Seed with thick woody outer coat, its inner layer irregularly folded into the white endosperm. Seed-leaves 2.—Four species, 1 in California, 1 in Florida, and 2 in China and Japan. (John Torrey, Professor of Botany in Columbia College, long-time a student of western botany, who traveled in California before the days of the Overland Railroad.)

California Nutmeg.

1. TORREYA CALIFORNICA Torr. *Tumion californicum* Greene. Figs. 73 and 74.

Leaves rigid, 1¼ to 2½ inches long, 1½ lines wide, flat, dark green above, yellowish green beneath and with two longitudinal glaucous grooves, linear or somewhat tapering above, the apex armed with a stout short bristle, twisted on their short petioles so as to form a 2-ranked flat spray; stamen-clusters whitish, globose, about 3 lines long, crowded on the under side of the branches; fruit elliptical, green in color or when ripe streaked with purple, 1⅛ to 1¾ inches long; flesh thin and resinous; shell of the seed more or less longitudinally grooved; embryo minute (a line long), placed at the upper end of the seed; endosperm copious, with irregular incisions filled by the inner coat, giving it a marbled appearance so that in cross-section the seed resembles the true nutmeg of commerce.

California Nutmeg is a handsome tree 15 to 50 feet high with dark green foliage. The straight trunk is ½ to 3 feet in diameter with dark smoothish and thin bark. It is most readily recognized by its rigid bristle-pointed leaves spreading in two opposite rows and by its fleshy fruits which strikingly resemble a plum or olive.

Fig. 73. CALIFORNIA NUTMEG (*Torreya californica* Torr.). Fruiting branch, ½ nat. size.

Torreya californica inhabits cool shady cañons or sheltered slopes and is distributed in the Coast Ranges from the Santa Cruz Mountains north to Marin, Napa, southern Mendocino and Lake counties, and in the Sierra Nevada (west slope) from Lassen Butte to Tule River. While its range is fairly extensive the localities are comparatively few in number and the trees few in a locality. It is, for example, scattered along the Merced River, from El Portal to the lower Yosemite, one tree or bush about every one hundred yards on the average, but never in groves or even groups.

The wood is fine- and close-grained, elastic, rather heavy and very durable. It has been used by settlers for bridge timbers by virtue of its lasting quality, but being susceptible of a beautiful finish it would commend itself for many kinds of fine work did it occur in commercial quantity.

The fruit in its internal structure is suggestive of the Nutmeg of commerce, Myristica fragrans of the tropics. This resemblance is however purely superficial, since neither in botanical nor in economic character are the fruits alike.

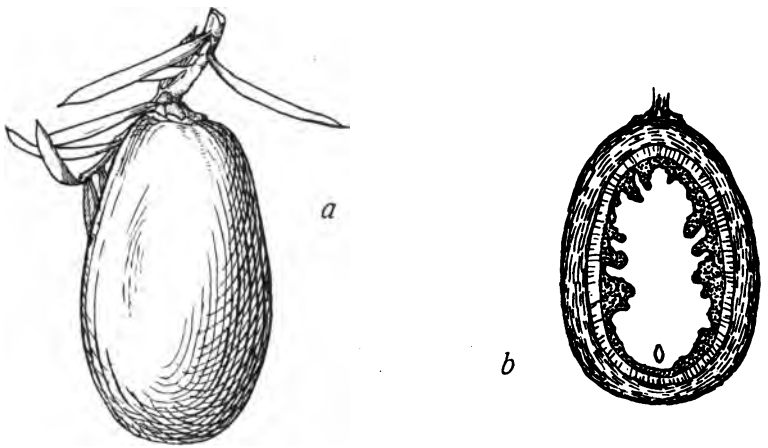

Fig. 74. CALIFORNIA NUTMEG (*Torreya californica* Torr.). *a*, The plum-like fruit; *b*, longitudinal section, showing the analogy of the fruit to that of the true Nutmeg of commerce. nat. size.

Division II.
PALM TREES. (MONOCOTS).

Palm or palm-like trees, the trunk simple or sparingly branched. Leaves parallel-veined, borne in a tuft at summit of stem or end of branches. Stem increasing in diameter by irregular growth, not by definite concentric layers. Flowers with the parts in 3s or 6s. Seed-leaf 1.

LILIACEAE. LILY FAMILY.

Perennial herbs, the stems from bulbs, corms or root-stocks, scape-like with basal leaves, or leafy and branching, with us rarely shrubs or trees. Flowers regular, perfect, the perianth with 6 lobes or 6 distinct segments, the 3 outer nearly like the 3 inner, or very unlike, all often colored alike. Stamens 6, sometimes 3, rarely 4. Ovary superior, 3-celled;

style 1. Fruit a capsule, rarely a berry.—A large order, widely distributed in both hemispheres, about 200 genera.

1. YUCCA L. Spanish Bayonet.

Trees or shrubs with simple or branched stems. Leaves alternate, linear-lanceolate. Flowers large, in terminal panicles, the perianth segments distinct, nearly equal, withering-persistent. Stamens 6. Fruit a capsule, either dry and dehiscent, or somewhat fleshy and indehiscent. Seeds numerous, in 2 rows in each cell, flat, horizontal, with thin black coat.—The flowers are incapable of self-pollination, each Yucca species being dependent upon a particular moth or species of Pronuba. The female Pronuba works by night, collecting the pollen from the anthers and rolling it into a little ball; she then flies to the flower of another plant, deposits her egg in the ovary and then, in a manner which seems to indicate that her actions are full of purpose and deliberation, climbs to the style and thrusts the pollen ball far down the stigmatic tube. The larva destroys about a dozen seeds, but even if several larvae develop, many perfect seeds are left.—Southwestern United States, Mexico and Central America, about 20 species. (Indian name for the Manihot, erroneously transferred to these trees.)

Trunk at summit branching freely; leaves tapering from base to apex, serrate on margin.....1. *Y. brevifolia.*

Trunk simple or shortly branched; leaves widest at middle, tapering to apex and to the abruptly widened base, smooth or fibrous on margin.....2. *Y. mohavensis.*

Joshua Tree.

1. Yucca brevifolia Engelm.

Leaves bayonet-like, bluish green, 1½ inches wide at base, tapering gradually to the apex, the edge with minute teeth; flowers greenish white; stigma sessile, 6-lobed; fruit oblong-ovate, slightly 3-angled, 2 to 4 inches long and 1½ to 2 inches broad.

Joshua Tree is a peculiar tree commonly 20 to 30 feet high with an open crown of arm-like branches, the columnar trunk 8 to 15 feet high and 1 to 3 feet in diameter. It inhabits arid mesas and mountains and is distributed from the western arm of the Mohave Desert to Walker Pass at 5,000 feet (where it descends into the Kern River Valley) and Coso mountains *near* Owen's Lake, thence eastward through southern Nevada

to southwestern Utah. The trees form in many places, notably on the Mohave Desert, scattered groves where they impart to the desert landscape a singularly weird appearance. The stem does not branch until after the first flowering and is densely clothed with stiff spiny serrate leaves, all of which point upwards. After the plant flowers the old leaves die, turn outwards and downwards, falling in one or two years, and the trunk then branches from lateral buds formed beneath the terminal flower bud.

Mohave Yucca.

2. YUCCA MOHAVENSIS Sarg.

Leaves bayonet-like, 16 to 24 inches long, widest at middle and tapering to apex and also to the abruptly widened base which is 3 inches wide, the margin with loose fibers, not serrate; flowers in a panicle 1 to 1½ feet long; style short, 3-lobed; fruit 3 to 4 inches long, 1½ inches thick, usually constricted about the middle.

Mohave Yucca, often called Spanish Dagger, is a cactus-like shrub or a low tree up to 10 or 15 feet high. The trunk is simple, or with a few very short branches, and about 6 inches in diameter; on the coast this plant is usually stemless.

Yucca mohavensis is scattered over deserts, mountain slopes and plateaus from southern Nevada and northeastern Arizona westward to the Mohave desert, thence southward to western San Diego County and northerly along the coast to Monterey County. The leaves were one of the resources of the native tribes of the desert for fibres, being manufactured into blankets and cords.

PALMACEAE. PALM FAMILY.

Commonly trees with fibrous roots and columnar unbranched trunks covered with leaf-scars or the bases of leaf-stalks and bearing a tuft of large leaves at summit. Leaves sharply plaited when young, eventually tearing more or less along the lines of the folds. Flowers commonly monoecious, borne in a large paniculate spike enclosed by a spathe. Perianth inconspicuous, with 3 to 6 equal segments. Stamens commonly 6. Carpels 3, separate or united, each 1-ovuled. Fruit a berry, drupe or nut.—Tropical and subtropical, 128 genera.

1. **WASHINGTONIA** Wendl. FAN PALM.

Trees with fan-shaped much folded leaves and long petioles armed with stout hooked spines along their margins. Flowers

perfect. Fruit a berry.—Three species: W. sonorae Wats. of Sonora, Mexico; W. gracilis Parish, cultivated in California gardens and doubtless native of northern Lower California; and the following. (In honor of President Washington.)

California Fan Palm.

1. WASHINGTONIA FILIFERA Wendl. Figs. 22 and 23.

Leaves fan-shaped, 3 to 6 feet long, with 40 to 60 folds, torn nearly to the middle, the divisions copiously fibrous; petioles 2 to 5 feet long, very stout; flowers perfect, borne in a branching spike on a long stem, the whole 8 to 12 feet long; calyx tubular; corolla funnel-shaped with the stamens inserted on its tube; berries borne on pedicles 1 to 1½ lines long, black, oval, 3 to 3½ lines long, with thin flesh surrounding a large seed which is flattened somewhat on the ventral side; endosperm horny.

California Fan Palm is a columnar tree 20 to 75 feet high, the trunk unbranched, 1 to 3 feet in diameter at the enlarged base, covered with a scaly rind and sometimes clothed quite to the ground with a thatch of dead persistent recurved leaves. It grows along alkaline streams, rivulets or springs on the northwestern and western margins of the Colorado Desert (a one-time inland sea) and thence southward to Lower California. The known localities are comparatively few in number. On the north side of the desert the stations from east to west are Dos Palmos, One Thousand Palms, Seven Palms and White Water Cañon, the latter the most westerly locality on this side of the desert. The stations on the west side in order from north to south are Snow Creek, Andreas Cañon, Murray Cañon, Lukens Cañon, Palm Cañon (all the foregoing at east or northerly base of Mt. San Jacinto), Piñon Flat, Coyote Cañon (and Thousand Palms Cañon), Palm Cañon (San Ysidro), and Seventeen Palms.

Division III.
BROAD-LEAVED TREES. (DICOTS).

Deciduous or evergreen trees, the trunk freely parting into branches, rarely persistent through crown as a continuous axis. Leaves netted-veined. Stem increasing in diameter by annual concentric layers of wood laid down inside the bark. Flowers with the parts in 4s or 5s, the perianth commonly *differ*entiated into calyx and corolla, sometimes absent. Seed-

leaves 2. Vegetative reproduction by stump-sprouting very common.

SALICACEAE. WILLOW FAMILY.

Deciduous trees or shrubs of rapid growth, light wood and bitter bark. Leaves simple, alternate, with stipules. Flowers dioecious, arranged in catkins, these falling off as a whole, the staminate after shedding the pollen, the pistillate after ripening of the fruit and dispersion of the seeds. Bracts (or scales) of the catkin scale-like. Calyx and corolla none. Stamens 1 to many. Ovary 1-celled; stigmas 2. Fruit a 2 to 4-valved capsule enclosing many seeds furnished with a tuft of hairs at base.—Two genera, northern hemisphere mainly.

Scales entire or merely denticulate, persistent or sometimes deciduous; flowers without disk; stamens usually 1 to 5; stigmas short. 1. SALIX.

Scales fimbriate or lacerate, caducous; flowers with a broad disk; stamens usually numerous; stigmas elongated or conspicuously dilated..... .....2. POPULUS.

1. SALIX L. WILLOW.

Trees or shrubs with mostly narrow short-petioled leaves. Winter buds covered by a single scale. Catkins mostly erect, appearing before or with the leaves; scales entire or merely denticulate, persistent. Staminate flowers with 1 to 9 stamens and 1 or 2 little glands. Pistillate flowers with a gland at the base of the ovary. Stigmas short.—Chiefly north temperate and arctic, about 160 species, 18 in California, of which 12 (at least in their most typical forms) are shrubs. (Classical Latin name of the Willow.)

Stamens 3 to 9, their filaments hairy or woolly below; style short; stigmas roundish, subentire; scales pale or yellowish, in the pistillate catkin more or less deciduous by maturity; capsules pediceled; trees, mainly of lower altitudes.

Petioles with wart-like glands at summit; leaves lanceolate, long-pointed; stipules usually present, roundish; catkins in bud tapering, in flower usually straight, their scales erect..1. *S. lasiandra.*

Petioles not glandular; stipules usually absent; catkins in bud cylindric.

Leaves broadly lanceolate, acute, shining green above, usually glaucous beneath; staminate catkins curving; scales reflexed or spreading.....2. *S. laevigata.*

Leaves very narrow, nearly alike on both faces, finely serrulate, often curving towards apex.....3. *S. nigra.*

Stamens 2 (rarely 1), their filaments glabrous; stigmas entire or notched, rarely parted into linear lobes; scales usually black or dark-colored, mostly persistent.

Capsules glabrous; leaves dark green above, white-pubescent beneath; catkins sessile, leafless; filaments more or less united; small tree or shrub; foothills mainly.....4. *S. lasiolepis.*

Capsules tomentose, silky or puberulent.

Style none; catkins short and dense, their scales black, with white hairs; leaves obovate, usually glabrate.5. *S. flavescens.*

Style evident; catkins long and slender; stamen 1, or if 2 the filaments partly united; leaves conspicuously silky beneath .....6. *S. sitchensis.*

Yellow Willow.

1. SALIX LASIANDRA Benth. Figs. 75c, d, and 76b.

Young leaves lanceolate or oblanceolate, acuminate, glandular-serrulate, with small suborbicular stipules; mature leaves lanceolate with long tapering or very slender point, green above, conspicuously glaucous beneath, 4 to 7 inches long, ⅝ to 1¼ inches wide; petioles 3 to 9 lines long, glandular at the upper end; stipules on vigorous shoots conspicuous, orbicular, 5 to 12 lines wide; staminate catkins 1¼ to 3 inches long, usually straight; pistillate catkins 1¼ to 2¼ inches long, 3 lines thick; scales erect, oblong-lanceolate, thin, nearly or quite glabrous on the back, hairy at base, the staminate yellow, the pistillate brown and mostly deciduous in fruit; stamens 4 to 9; ovary and capsule glabrous.

Yellow Willow, also called Black Willow, is a tree 20 to 45 feet high with a broad open crown of upright branches and brown roughly fissured trunk bark. The one-winter-old branchlets are yellowish, the winter buds short, blunt, and keeled on the back.

Salix lasiandra grows along the Sacramento and San Joaquin rivers and their tributaries, and fringes most Coast Range streams and creeks where the water flow is not intermittent; it occurs chiefly between 10 and 500 feet but ascends to 4,500 feet in the northern and to 8,500 feet in the southern Sierra Nevada. Beyond our borders it ranges north to British Columbia and Idaho. It is most easily recognized in the field by its glandular-warty petioles and long tapering leaves.

Red Willow.

2. SALIX LAEVIGATA Bebb. Figs. 75a, b and 76c.

Young leaves broadly oblong, acute at each end, disposed to be broadest above the middle, mucronate, entire, soon becoming serrulate, often nearly alike on both faces; stipules minute and caducous or none; mature leaves oblong-lanceolate to lanceolate, obtusish at base, acute at apex or sometimes long-pointed, serrulate, glabrous, green and shining above,

pale or conspicuously glaucous beneath, 2½ to 7⅙ inches long, ⅝ to 1¼ inches wide; petioles ½ to 4 lines long; staminate catkins commonly flexuous, 1½ to 4½ inches long, 4 or 5 lines thick; pistillate catkins ¾ to 2 inches long, 2 lines thick; scales soon spreading or reflexed, elliptic, blunt, woolly at base, glabrous and pallid towards apex, 2 to 4-toothed, the staminate yellow, the pistillate gray and tardily deciduous; stamens 4 to 7 (sometimes 3); ovary and capsule glabrous; style very short; stigmas roundish.

Red Willow is a tree 20 to 50 feet high with broad round crown of erect slender branches. The trunk bark is roughly

Fig. 75. RED WILLOW (*Salix laevigata* Bebb); *a*, staminate catkin; *b*, pistillate catkin. YELLOW WILLOW (*Salix lasiandra* Benth.); *c*, staminate catkin; *d*, pistillate catkin. nat. size.

fissured. The one-winter-old branchlets are reddish brown with pointed ovate winter buds.

Salix laevigata grows along living streams or occasionally along summer-dry arroyos in regions of high winter precipitation and is distributed through the Coast Ranges, Great Valley and Sierra Nevada (especially the foothills) to Southern California. Beyond our borders it extends north to southern British Columbia. Altitudinally it ranges from near sea-level to about 4,500 feet in the southern Sierra Nevada. It is commonly an associate of the Yellow Willow and has been variously called Bebb Willow, Smooth Willow and Spotted-leaf Willow.

Black Willow.

3. SALIX NIGRA Marsh. Fig. 76a.

Leaves lanceolate or linear-lanceolate, long-pointed, often falcate, serrulate, glabrous, green on both surfaces, 2 to 5 inches long, 2 to 3 lines wide; petioles 1 line long; stipules early deciduous; scales obovate, yellow, hairy, erect; staminate catkins 1½ to 2½ inches long; stamens 3 to 5; pistillate catkins ¾ to 1¼ inches long, in fruit 1 to 2½ inches long, becoming rather lax; ovary scantily pubescent or hoary; capsule glabrous, reddish brown.

Black Willow is a tree 20 to 45 feet high with a roundish open crown of erect branches, the trunk with rough dark bark. It inhabits river banks in the Sacramento and San Joaquin valleys and follows the desert rivers through southeastern California and across southern Arizona to New Mexico and thence eastward to Texas and the Mississippi Valley, ranging as far north as Lake Superior and New Brunswick. It has a more extensive range than any other tree in the United States except the Aspen and is with the Aspen one of the two California trees in common with the silva of Eastern North America.

Arroyo Willow.

4. SALIX LASIOLEPIS Benth. Figs. 78a, b, e, and 77.

Mature leaves oblong, obovate or linear, acute, obscurely serrulate, dull green and glabrous above, white-pubescent or pale beneath, 1½ to 5 inches long, ⅓ to 1¼ inches wide; petioles 1 to 8 lines long; catkins appearing before the leaves, sessile, densely silky-tomentose in the bud, suberect; scales dark; staminate catkins ¾ to 1½ inches long, 5 to 6 lines thick; stamens 2, filaments glabrous, more or less united below; pistillate catkins ¾ to 1 inch long, 3 to 4 lines thick, in fruit 1½ to 2¼ inches long; capsule glabrous or puberulent, short-pediceled.

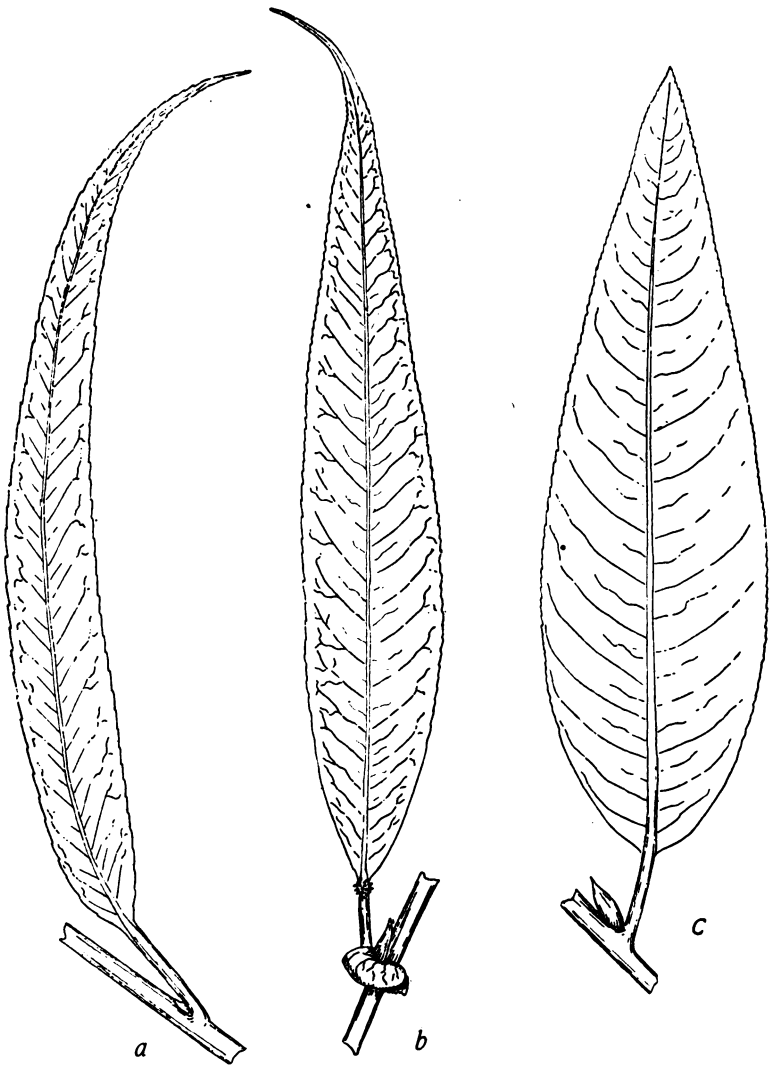

Fig. 76. *a*, BLACK WILLOW (*Salix nigra* Marsh), leaf. *b*, YELLOW WILLOW (*Salix lasiandra* Benth.), leaf. *c*, RED WILLOW (*Salix laevigata* Bebb), leaf. nat. size.

Arroyo Willow, often called White Willow, is a shrub or tree 8 to 20 or rarely 35 feet high with an irregular crown of spreading branches. The trunk is 3 to 9 inches in diameter, the bark smooth or on old trunks shallowly seamed.

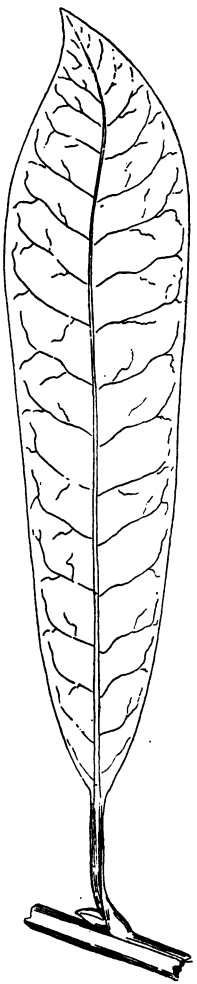

Fig. 77. ARROYO WILLOW (*Salix lasiolepis* Benth.). Leaf, nat. size.

Salix lasiolepis is distributed throughout the Coast Ranges, Great Valley and Sierra Nevada foothills, thence southward into Southern and Lower California. It is also reported from Arizona.

Growing along living streams in the valleys, Arroyo Willow also follows intermittent water-courses into the dry hills where it is the most characteristic willow in the beds of arroyos and gulches chiefly between 100 and 2,500 feet altitude. It is a variable willow, yet its eccentricities are rather easily comprehended because very divergent states, especially leaf forms, may be collected from a single individual. Typically an inhabitant of the foothills it ranges occasionally to altitudes of 4,000 feet.

Nuttall Willow.

5. SALIX FLAVESCENS Nutt. Fig. 78c, d, f.

Leaves broadly obovate or oblong-obovate, entire, rounded at apex or shortly acute, 1 to 1½ (or 4) inches long, ½ to 1¼ inches wide, yellow-green and lustrous above, yellow-veined, glabrate or densely short-silky beneath; petioles 4 lines long; catkins appearing before the leaves, oblong or elliptic, ½ to ¾ inch long, 5 to 6 lines thick, sessile; bracts obovate, rounded at apex, black or black-tipped, densely silky; stamens 2, conspicuously long-exserted, filaments glabrous; ovary white-silky, style none, stigmas broadly linear, notched or deeply lobed; capsules less silky than the ovary.

Nuttall Willow in California is usually a straggly shrub 2 to 8 feet high, or rarely a tree up to 25 feet high with a trunk ¾ to 1¼ feet in diameter. It inhabits

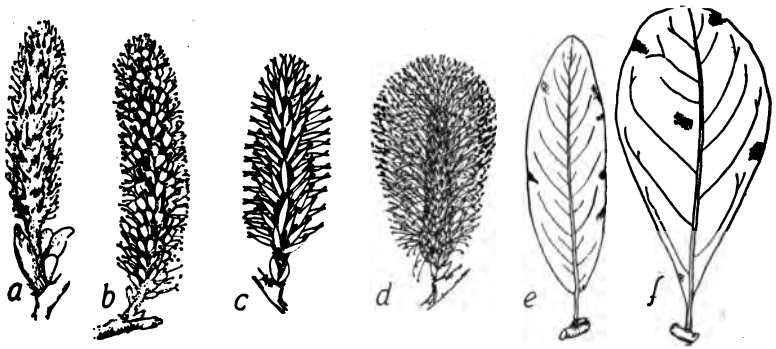

Fig. 78. ARROYO WILLOW (*Salix lasiolepis* Benth.); *a*, pistillate catkin; *b*, staminate catkin; *e*, leaf. NUTTALL WILLOW (*Salix flavescens* Nutt.); *c*, pistillate catkin; *d*, staminate catkin; *f*, leaf. Catkins nat. size; leaves ½ nat. size.

moist north slopes or the vicinity of springs in the hills or mountains. In the Coast Ranges it is limited to the vicinity of the sea; in the Sierra Nevada and in the San Bernardino Mountains it occurs between 4,000 and 10,000 feet. Beyond our borders it ranges north to British Columbia and throughout the Rocky Mountains in the United States.

Velvet Willow.

6. SALIX SITCHENSIS Sanson.

Leaves obovate to oblanceolate, rounded or shortly acute at apex, entire (obscurely serrulate on vigorous shoots), dark green and almost glabrous above, densely tomentose and lustrous silky beneath, 2 to 5 inches long, 1 to 3 inches wide; petioles 1 to 6 lines long; stipules small, early deciduous or on sterile shoots broad or orbicular, 4 to 6 lines long; staminate catkins 1¼ to 2 inches long, 5 to 6 lines thick; stamens 1, or exceptionally 2, and their filaments more or less united; pistillate catkins ¾ to 2 inches long, 3 lines thick, in fruit 3 to 5 inches long; bracts covered with long white silky hairs, the staminate rounded at apex, the pistillate shorter, broader and more acute; style elongated, stigmas short-oblong, entire or nearly so.

Velvet Willow, often called Sitka Willow or Silky Willow, is a shrub 5 to 12 feet high or a tree up to 25 feet high, the trunk 2 to 10 inches in diameter. It is distributed along the California coast from the Santa Lucia and Santa Cruz mountains north to Marin and far north to Alaska. It also occurs in the Sierra Nevada on the west slope at 5,000 to 7,000 feet.

This species is most readily known by its obovate leaves, densely white-silky on the under surface and glossy dark green above.

2. **POPULUS** L. Poplar.

Trees with scaly buds and caducous stipules; leaves rather long-petioled, broad. Winter buds covered by many scales,

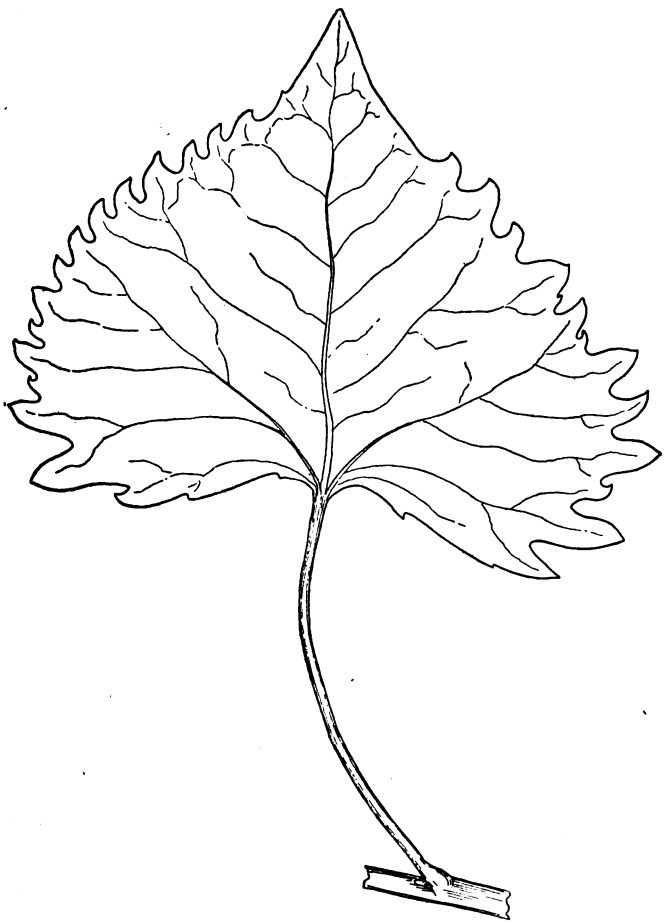

Fig. 79. Common Cottonwood (*Populus fremontii* Wats.). Typical leaf, nat. size.

Catkins appearing before the leaves, in ours pendulous; scales imbricate or lacerate, falling as soon as released by the elongation of the catkin. Stamens inserted on the surface of a concave disk. Ovary seated on a collar-like disk; style short, stigmas 2 to 4, narrow and elongated, or conspicuously dilated. Coma of the seeds long and conspicuous. — Northern hemisphere, about 25 species. (Classical Latin name of the Poplar.)

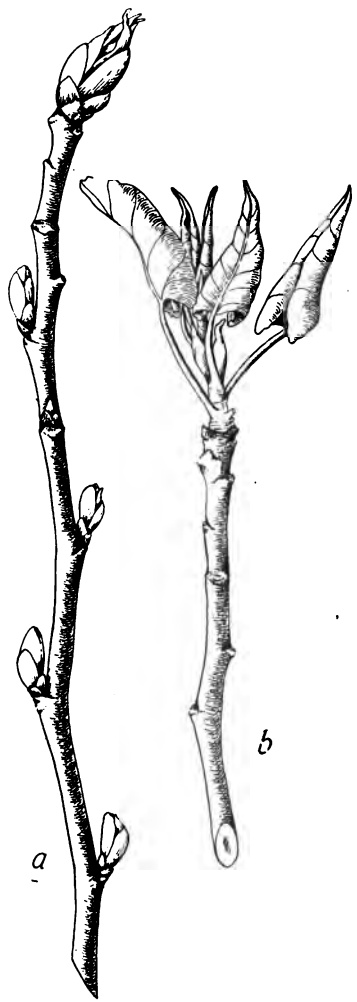

Fig. 80. Common Cottonwood (*Populus fremontii* Wats.). Winter branchlets with bursting buds, showing the unfolding involute leaves. ½ nat. size.

Stamens 40 to 80.

Leaves deltoid-orbicular, 2 to 4 inches broad, broader than long, yellowish green, alike on both faces; valley streams. .....1. *P. fremontii.*

Leaves ovate, 2½ to 7 inches long, longer than broad, ovate, dark green above, rusty or silvery beneath; valley and mountain streams. .....2. *P. trichocarpa.*

Stamens 6 to 12; leaves round-ovate, 1 to 2 inches long; high mountains.....3. *P. tremuloides.*

Common Cottonwood.

1. Populus fremontii Wats. Figs. 79 and 80.

Leaves triangular or roundish in outline, 2 to 4 inches broad, broader than long, the margin crenate except at the abruptly short-pointed apex and the truncate or subcordate base; scales regularly laciniate-fringed, shorter than the flowers; staminate catkins finally 2 to 4 inches long, densely flowered; stamens 48 to 72; pistillate catkins 2 inches long (becoming twice as long in fruit), loosely flowered; ovary sinuously and strongly ridged about its middle and crowned with 3 or 4 roundish

stigmas; capsule ovate, roughish on the surface, 4 to 5 lines long, borne on pedicels 2 lines long, opening by 3 or 4 valves; seeds copiously provided with long white hairs which soon involve the catkin in a soft cottony mass.

Common Cottonwood, sometimes called Fremont Cottonwood, is a handsome tree 40 to 90 feet high with ascending or wide-spreading branches forming a round-topped massive yellow-green crown supported on a short or long trunk 1 to 5 feet in diameter. The bark is white or whitish, on the trunk 1 to 5 inches thick and roughly fissured.

Populus fremontii inhabits stream beds and moist deltas in the valleys, rarely entering dry foothills except along living streams. It is distributed from near Redding southward through the Sacramento and San Joaquin valleys, Sierra Nevada foothills and South Coast Ranges to the Mohave Desert and Southern California nearly to the Mexican boundary. It shuns the coast fog belt and is rare in the North Coast Ranges, being noted by the writer only along the Russian River between Cloverdale and Ukiah, on the forks of the upper Eel River in Round and Gravelly valleys and in the intervening country. Its altitudinal range is chiefly between 50 and 2,000 feet.

Black Cottonwood.

2. POPULUS TRICHOCARPA T. & G. Fig 81a.

Leaves broadly or narrowly ovate, finely serrate, truncate or heart-shaped at base, acute or tapering to a point at apex, 2½ to 7 (or even 10½) inches long, lustrous green above, rusty-brown beneath when young but at length whitish; staminate catkins 1 to 2 or eventually 5 inches long; stamens 40 to 60 on a slightly one-sided disk; pistillate catkins loosely flowered, 2½ to 3 inches long, in fruit 4 to 10 inches long; stigmas 3, dilated and deeply lobed; capsule nearly sessile, 3-valved, containing seeds with long lustrous hairs.

Black Cottonwood is a tall tree, 40 to 100 feet high, with a rather broad crown of upright branches supported on a trunk 1 to 3 feet in diameter. The trunk bark is smooth, whitish with a usually yellowish cast, or on old trunks longitudinally fissured into long, narrow and rather smooth-surfaced dark plates.

Populus trichocarpa inhabits banks of valley or mountain streams or moist bottoms and is distributed through the Coast Ranges and Sierra Nevada, thence south to Southern California as far as Palomar Mountain (south limit). In the Sierra Nevada it occurs chiefly between 3,000 and 6,000 feet.

There are fine trees on the floor of Yosemite Valley opposite Yosemite Falls, and in lower Hetch-Hetchy Valley. In the Coast Ranges it is found on most perennial streams in the Santa Lucia Mountains, is abundant on the Pajaro River between Pajaro and Sargent, is scattered along Carnadero Creek in the Gilroy Valley, along Alameda Creek near Niles, and occurs in Mitchell Cañon at Mt. Diablo. In the North Coast

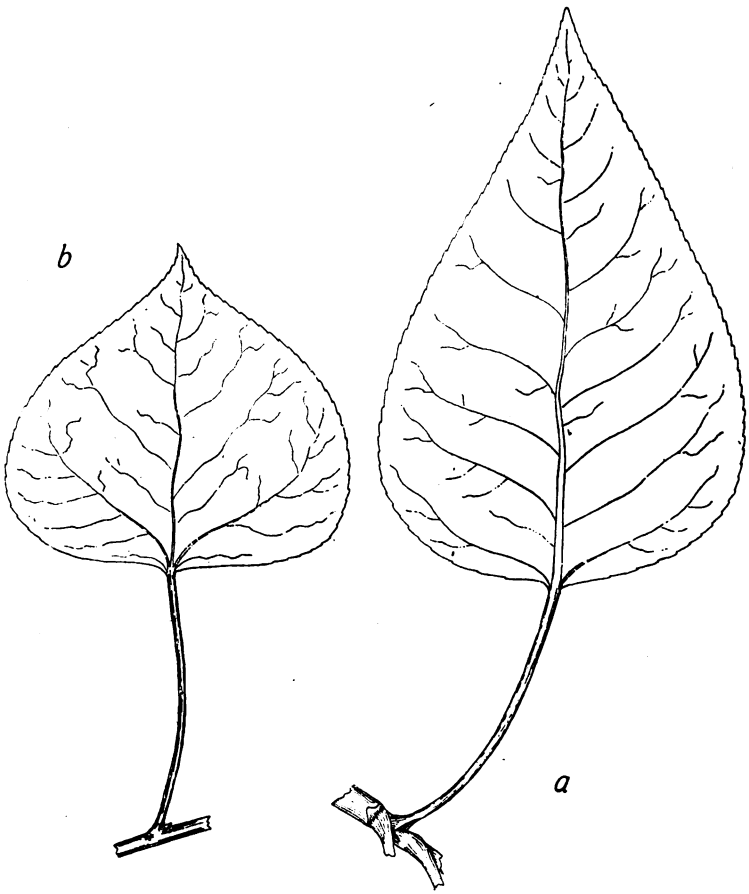

Fig. 81. *a*, BLACK COTTONWOOD (*Populus trichocarpa* T. & G.), leaf, nat. size to ½ nat. size. *b*, ASPEN (*Populus tremuloides* Michx.), leaf, nat. size.

Ranges it is found on the forks of the upper Eel River in eastern Mendocino; on the Mattole River near Petrolia where there are splendid specimens; and in Scott Valley (Siskiyou County) where it is abundant and reaches its greatest development in California. Beyond our borders it ranges north through Oregon and Washington to southern Alaska.

Aspen.

3. POPULUS TREMULOIDES Michx. Fig. 81b.

Leaves round-ovate or orbicular, finely toothed or almost entire, abruptly tipped at apex with a short sharp point, 1 to 2 inches long; staminate catkins 1½ to 2½ inches long; stamens 6 to 12; pistillate catkins 2 to 4 inches long; ovary conical; stigmas 2, very thick below, divided above into 2 slender spreading lobes; seeds minute, brownish, bearing long white hairs.

Aspen is a slender tree with graceful declined or pendulous branches, 10 to 60 feet high, the trunk 3 to 6 inches in diameter. The bark is greenish white or on old trunks nearly black. It inhabits margins of swampy meadows or gravelly slopes and occurs throughout the Sierra Nevada between 5,000 and 8,000 feet at the north and 6,000 to 10,000 feet at the south. At the upper end of Lake Merced eight miles east of the Nevada Fall is a beautiful grove of these trees which are 60 to 80 feet high with trunks 1 to nearly 2 feet in diameter at 4½ feet. In Southern California there is a restricted area in the San Bernardino Mountains in upper Fish Creek Cañon north of San Gorgonio Peak. Aspen does not occur on Mt. Shasta and is unknown in the Coast Ranges except on Cañon Creek in the Trinity Mountains.

Beyond our borders Aspen ranges widely through the Rocky Mountain region, north to Alaska and Hudson Bay, south to Tennessee, Mexico and Lower California. It is more widely distributed than any other North American forest tree and is the only Californian species which reaches the arctic circle.

JUGLANDACEAE. WALNUT FAMILY.

Trees with pinnately compound leaves without stipules. Flowers monoecious, appearing after the leaves. Staminate flowers numerous in pendulous lateral catkins. Pistillate flowers few on short erect terminal catkins. Ovary 1 to 3-celled, inferior. Fruit a nut with a dry husk; seed one,

deeply 2-lobed.—Six genera, north temperate zone. The genus Carya, with 8 species in Eastern North America, is represented in California only by cultivated specimens of Shagbark Hickory and Pecan.

1. JUGLANS L. WALNUT.

Bark strong-scented. Branchlets hollow, divided into little chambers by pithy partitions. Buds nearly naked. Staminate flower with an irregularly 3 to 6-lobed calyx and numerous stamens. Pistillate flower with a 4-lobed calyx. Seed so lobed as to fit the irregularities of the nut.—Ten species, widely distributed. Four species in the United States, two in the East, a third, J. rupestris Engelm., occurs from Texas to Arizona. J. regia L., Persian or English Walnut, is extensively cultivated in California. (Latin Jovis, Jupiter, and glans, nut.)

California Black Walnut.

1. JUGLANS CALIFORNICA Wats. Figs. 82 and 83.

Leaves pinnately compound, with 11 to 19 leaflets, 6 to 13 inches long; leaflets oblong-lanceolate, serrate, 1½ to 4 inches long; staminate catkins 2 to 4 inches long, each flower with 20 to 26 stamens; nut globose, ¾ to 1¼ inches in diameter, the hard shell covered with a dry brown or in age black husk which does not separate from the shell or only in an irregular or partial manner; shell almost smooth but marked with a few shallow longitudinal grooves.

California Black Walnut is a large many-stemmed shrub 10 to 25 feet high, with roughish nearly black trunk bark. The foliage is aromatically pungent. It inhabits mountain slopes, stream beds or gravelly washes and is distributed from the Santa Maria watershed south to the Ojai Valley, Newhall, Santa Monica Mountains, eastward along the lower slopes of the Sierra Madre and San Bernardino mountains and south to the Puente Hills and Brea Cañon in the Santa Ana Range (south limits).

Juglans californica in typical low-branching form is limited to Southern California. While individuals are often of large size, even of elephantine proportions, they are after all shrubs architecturally. In northern California, on the contrary, the species is represented by a truly arboreous form which is a large tree with tall trunk and massive crown. It has been named variety HINDSII by the writer.

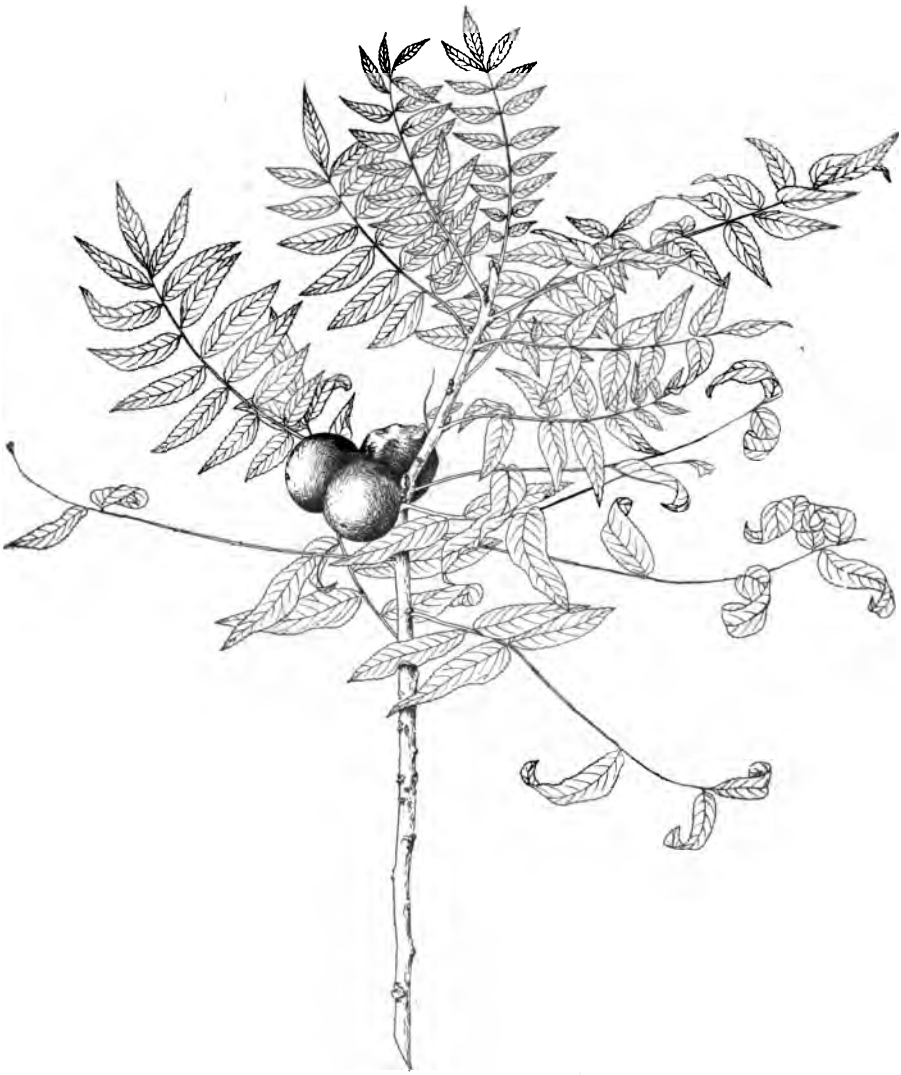

Fig. 82. CALIFORNIA WALNUT (*Juglans californica* Wats.). Fruiting branchlet, ⅓ nat. size. The leaflets are falling separately, instead of the leaf as a whole.

The variety occurs in northern California at a few stations, restricted in area and isolated from each other, as follows: 1. Along Walnut Creek from near the east arm of Moraga Valley nearly to Pacheco, a few trees on Lafayette and San Ramon creeks; 2. Lower Sacramento River about Walnut Grove; 3. Napa Range, east slope near Wooden Valley; 4. Gordon Valley, one tree (Ralph E. Smith). It has also been recently reported from other stations in northern California, stations to us dubious since particulars as to the habitats, and occurence and number of the trees are lacking. Along Walnut Creek and the Lower Sacramento River the trees are 50 to 75 feet high with tall trunks 1 to 3 feet in diameter. On account of their different habit and larger nuts (1 to 1¾ inches in diameter) the trees of northern California are at least varietally distinct from the southern type.

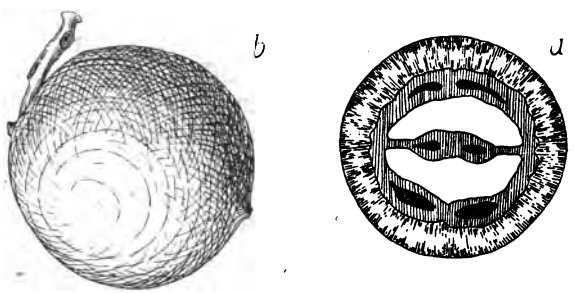

Fig. 83. CALIFORNIA WALNUT. *b*, Nut; *a*, cross section. nat. size.

Juglans californica occurs too sparingly to furnish a supply of timber of commercial importance. Horticulturally the tree plays an important part in the walnut industry, since it is universally used as a stock graft for English Walnut. It is also grown as a windbreak, and as a roadside tree for which purpose it is admirably adapted.

BETULACEAE. BIRCH FAMILY.

Wind-pollinated deciduous trees or shrubs with alternate simple petioled leaves and caducous stipules. Flowers small, borne in catkins. Staminate catkins elongated, pendulous,

falling after flowering, the flowers in clusters of 3 in the axil of each bract, consisting of a membranous commonly 4-parted calyx and 1 to 7 (commonly 2 or 4) stamens; bracts dilated above with the apex abruptly upturned, each covering 4 bractlets. Pistillate catkins small, erect, spike-like, the flowers 2 in the axil of each bract, without perianth, consisting of a pistil with 2 styles and a 2-celled ovary with 1 ovule in each cell. Ripened catkins enlarged, cone-like. Fruit a very small compressed 1-seeded nutlet which is margined or winged.—Two genera.

Pistillate catkins in clusters, forming in fruit oval or ovoid woody cones; cones drooping or spreading, eventually falling whole, their scales obscurely 5-lobed at apex; stamens 1 to 7.....1. ALNUS.

Pistillate catkins solitary, forming cylindrical cones; cones erect in fruit, falling to pieces when mature, their scales plainly 3-lobed at apex; stamens 2. .....2. BETULA.

1. ALNUS L. ALDER.

Staminate catkins few to several in a cluster; calyx 4 (or 6)-parted; stamens 1 to 7. Pistillate catkins in clusters of 2 to 4, forming woody pendulous cones when mature, the bracts and bractlets united into 5-lobed scales persistent on the axis. Nutlets roundish, flattened, with a narrow acute margin.—North temperate regions, a few ranging in the high mountains to Bolivia; about 18 species, 9 in North America. (The classical Latin name.)

Catkins appearing in the early autumn as rather conspicuous naked buds and flowering in the late winter or early spring before the leaves appear; peduncles of the pistillate catkins naked, their branches ½ inch long or less; sepals 4; stamens 1 to 4.

Trees 30 to 80 feet high; mostly of low altitudes.

Leaf-margin plane, with small scattered teeth; bracts of staminate catkin obtuse; stamens 1 to 3, rarely 4....1. *A. rhombifolia.*

Leaf-margin with narrowly revolute edge, rather coarsely toothed; bracts of staminate catkins acute or acutish; stamens 4, rarely 3.....2. *A. rubra.*

Shrubs 8 to 15 feet high; leaf-margin coarsely toothed and again finely toothed; stamens 4 or 2; high-montane....3. *A. tenuifolia*

Catkins appearing in the spring from scaly buds at the same time as the leaves; peduncles of the pistillate catkins leafy (at least at base), their branches ½ to 1 inch long; sepals 6; stamens 6 or 7; leaf-margin sharply or laciniately toothed; high-montane shrub.... .....4. *A. viridis.*

White Alder.

1. ALNUS RHOMBIFOLIA Nutt.

Leaves 2 to 4 inches long, minutely pubescent, elliptic and obtuse, or most commonly oblong-ovate or oblong-rhombic and tapering more or less to the apex, at base broadly wedge-shaped and entire, the remainder of the margin provided with very small and more or less unequal glandular teeth; staminate catkins slender, 2 to 7 in a cluster, 2 to 5 inches long; sepals 2 to 4, most commonly 3, often unequal, one usually very small when the number is 4; stamens 2, less commonly 1 or 3; pistillate catkins 3 to 7 in a cluster, erect or ascending, and 5 to 6 lines long; cones ovoid, 5 to 9 lines long.

White Alder is a tree 30 to 100 feet high with a thin or open crown, tall slender trunk 1 to 3½ feet in diameter, and smooth whitish or gray-brown bark. As an inhabitant of river banks or cañon streams it grows in the Sierra Nevada up to 2,500 feet at the north and 6,000 or 8,000 feet at the south, follows the main rivers in the Sacramento and San Joaquin valleys, extends westward through the Coast Ranges to the edge of the narrow coast belt occupied by the Red Alder, and ranges southward into Southern California (Sierra Madre, San Bernardino, San Jacinto and Cuyamaca mountains), and northward to the Cascades of Washington.

Alnus rhombifolia keeps to streams that are permanent and is to the traveler a more reliable sign of water than Sycamore or even Fremont Cottonwood, although of far less practical value than Cottonwood because not occurring in as strictly desert country. The files of trees in mountain gorges are of distinct value as stream-cover, as well as enhancing the beauty of the cañons by their long slender white trunks and airy crowns.

The wood is light, brittle and coarse-grained, warps and checks badly when sawn so that it is seldom milled. Settlers make local use of the slender trunks for studs and rafters in barns and employ the larger ones for the construction of log houses.

Red Alder.

2. ALNUS RUBRA Bong. Fig. 84.

Leaves 2 to 6 inches long, elliptic-ovate, often rusty beneath, with coarse teeth which are again finely toothed, the entire margin with a narrow underturned edge; staminate catkins stoutish, 3 to 7 inches long; stamens 4, sometimes 3, especially at upper end of catkin; pistillate catkins 4 to 6 lines long, maturing into oblong-ovoid cones ¾ to 1⅛ inches long.

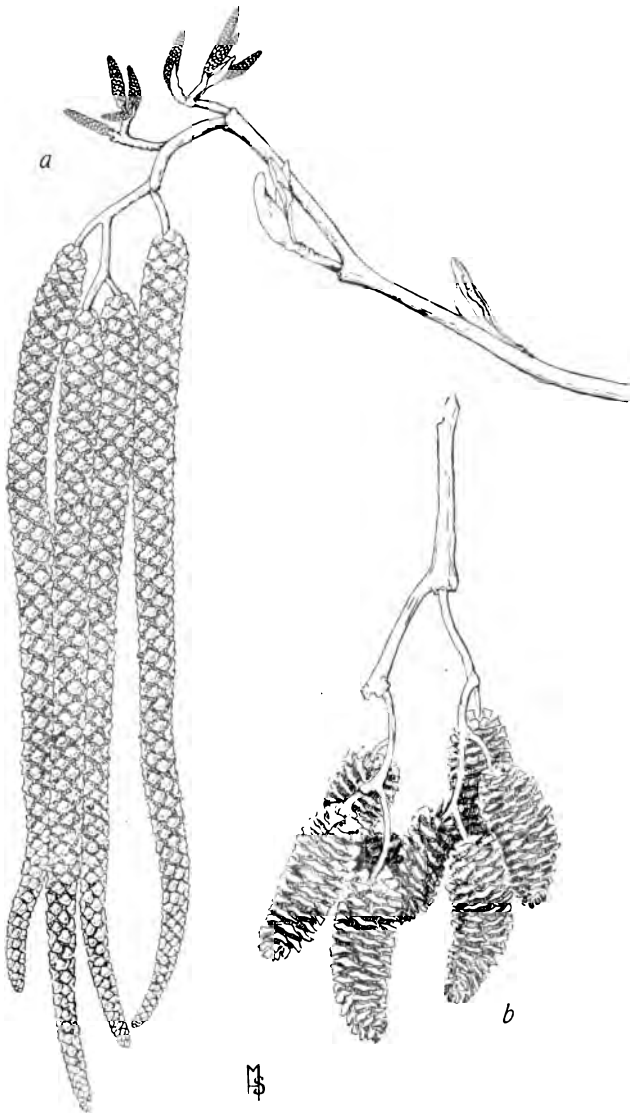

Fig. 84. RED ALDER (*Alnus rubra* Bong.). *a*, Branchlet in flower *with* pendulous staminate catkins and erect pistillate catkins; *b*, open cones *in winter condition*. ⅔ nat. size.

Red Alder is a tree 25 to 90 feet high with large roundish or depressed crown, the trunk 40 to 60 feet tall and 1 to 2½ feet in diameter. The bark is usually very white-mottled, red on the inside.

Alnus rubra grows in the beds of cool cañon streams or on moist flats. It is confined to a narrow strip along the coast from the Santa Inez Mountains northward to Del Norte County, ranging far northward to Alaska. In Marin, Mendocino and Humboldt counties it forms pure groves of great beauty in bottom lands near the sea.

The wood is soft, brittle and coarse-grained. It is useful for fuel, and has been used for piles, bridge foundations and boats.

3. **Alnus tenuifolia** Nutt. MOUNTAIN ALDER. Small tree or shrub 8 to 14 feet high; leaves roundish to ovate, thickish, at base truncately rounded (or even subcordate) to cuneate, coarsely toothed and again finely serrate, 1 to 3 inches long; staminate catkins 3 or 4 in a cluster, 3 inches long; stamens 2 to 4; pistillate catkins 3 to 8 in a cluster, sessile or with peduncles almost 2 lines long; cones small, 3 to 7 lines long.—Thickets on wet hillsides or in moist hollows at 5,000 to 7,000 feet altitude in the Sierra Nevada from Donner Pass northward to Mt. Shasta, thence westward to Trinity Summit and the Siskiyous. It has a wide distribution over western America.

4. **Alnus viridis** DC. var. **sinuata** Regel. THIN-LEAF ALDER. Slender shrub 6 to 10 feet high; leaves broadly ovate, thin, gummy when young, bright green, sharply or laciniately toothed, 2¼ to 3 inches long; catkins appearing in spring at the same time as the leaves, the peduncles of the pistillate leafy at least at base, their branches ½ to 1 inch long; sepals 6; stamens 6 or 7.—Trinity Summit, 6,000 feet; Mt. Shasta, 6,500 to 7,000 feet, far northward and northwestward.

2. BETULA L. BIRCH.

Staminate catkins 1 to 3 in a cluster, sessile or short-peduncled; calyx 4 (or 2)-lobed; stamens 2, each filament with 2 distinct anther-cells. Pistillate catkins solitary on the peduncle and erect, each scale consisting of the bract and 2 bractlets united. Cones long and slender, the scales falling away from the axis (on the tree) when the fruit is mature. Nutlet seed-like, with a broad thin wing.—Nine species in North America. B. papyrifera is the celebrated Canoe Birch of northern North America. (Latin name of the Birch.)

Leaves 1 to 2 inches long; lobes of bracts broad, usually parallel, acutish.....1. *B. occidentalis.*

Leaves ½ to 1 inch long; lobes of bracts narrow, divergent, obtusish .....2. B. glandulosa.

Water Birch.

1. BETULA OCCIDENTALIS Hook.

Leaves round-ovate, sharply serrate, mostly acute at apex, almost or quite glabrous and 1 to 2 inches long; petioles 4 or 5 lines long; staminate catkins 2 to 2½ inches long; pistillate catkins 1½ inches long in fruit, 3 or 4 lines in diameter; nutlets 1 to 1½ lines broad.

Water Birch, also called Black Birch and Red Birch, is a slender tree or tall shrub 10 to 25 feet high with red-brown smooth bark and warty twigs. It grows sparingly along streams in cañons on the west slope of the Sierra Nevada from Bubbs Creek (8,000 feet) northward to Mt. Shasta (2,500 to 5,000 feet), thence westward to the South Fork of the Salmon and to Humboldt County. It is most common with us along the water-courses on the eastern slope of the Sierra Nevada in the Owens Valley region where the poles are used for fencing.

2. **Betula glandulosa** Michx. SCRUB BIRCH. Shrub 1 to 4 feet high with glandular-warty twigs; leaves roundish, serrate except at base, ½ to 1 inch long; staminate catkins commonly solitary; pistillate catkins 4 to 9 lines long; nutlet 1 line broad.—High mountains of northern Sierra Nevada (Lassen County) and northward to the arctic circle, where it covers vast tracts of country.

FAGACEAE. OAK FAMILY.

Trees or shrubs with alternate simple leaves and promptly deciduous stipules. Flowers monoecious, apetalous, appearing with the leaves in the deciduous kinds. Staminate flowers in catkins; calyx parted into several lobes; stamens 4 to 12. Pistillate flowers 1 to 3 in an involucre of imbricated scales, the involucres borne in reduced or short catkins; ovary adherent to the calyx, 3-celled, 6-ovuled, only one ovule maturing, the remaining ovules and the other two cells abortive. Fruit a nut borne singly in a scaly cup or 1 to 3 in a spiny bur.—Five genera, chiefly north temperate zone and tropical Asia.

Fruit an acorn; catkins simple.
- Catkins unisexual, the staminate drooping.....1. QUERCUS.
- Catkins erect, all with staminate flowers, pistillate flowers at base of some of them.....2. PASANIA.

Fruit a spiny bur; catkins erect, often branching, unisexual, or with pistillate flowers at base of some of the staminate catkins.....3. CASTANOPSIS.

1. QUERCUS L. OAK.

Trees or shrubs of slow growth, hard wood and usually *contorted branches*. Flowers greenish or yellowish. Stami-

nate catkins pendulous, one or several from the lowest axils of the season's shoot. Pistillate flowers borne in the upper axils of the season's shoot, the ovary with 3 to 5 styles or stigmas. Fruit an acorn, the nut set in a scaly cup. Abortive ovules often discernible in the ripe or nearly ripe acorn.—About 300 species distributed over the northern hemisphere. California has 14 species, 9 trees and 5 shrubs; it is for its area strong in species but very weak in individuals. Washington has 1 and Oregon 5 species, all of which occur in California. (Latin name of the oak.)

White Oaks.—Bark commonly white or whitish, wood light-colored; stamens mostly 6 to 9; stigmas sessile or nearly so; abortive ovules mostly towards base of nut.

1. *Acorns ripe in first autumn; nut glabrous on the inner surface.*
   Deciduous species.
   Branchlets pendulous; acorn cups deep, the nut long and slender; leaves pinnately parted with coarsely 2 to 3-toothed lobes; trunk bark dark brown, deeply cuboid checked; valleys.....1. *Q. lobata.*
   Branchlets not pendulous; acorn cups shallow; trunk bark white, shallowly checked but smoothish.
   Leaves dark lustrous green above, rusty or pale beneath, 5 to 7-parted; nut subglobose or oblong-cylindric.
   Mossy trees; mainly north Coast Ranges...2. *Q. garryana.*
   Shrubs; montane.....Vars. of no. 2.
   Leaves bluish green above, pale beneath, oblong, coarsely toothed or entire; nut oval, often swollen at or below middle; dry foothills.....3. *Q. douglasii.*
   Evergreen species.
   Small tree; leaves blue-green, oblong, mainly entire; nut subcylindric; southern California.....4. *Q. engelmannii.*
   Shrubs; acorn cup saucer-shaped or turbinate.
   Branches rigid; leaves ¾ to 1 inch long.
   Leaves plane or undulate, oblong, entire or unequally spinose-serrate, mainly deciduous in late winter; nut oval to cylindric, rounded or pointed at apex; chaparral areas .....5. *Q. dumosa.*
   Leaves revolute, equally spinose-dentate, persistent through winter; nut short-cylindric, rounded at apex; inner Coast Ranges.....6. *Q. durata.*
   Branches slender, pliable; leaves 3 to 4½ inches long, strongly parallel-ribbed, toothed, chestnut-like; local in Siskiyous and vicinity .....7. *Q. sadleriana.*
2. *Acorns ripe in second autumn; nut tomentose or hairy within.*
   Trees; acorn cup usually very large and thick.

Leaves 2 to 3½ inches long, densely woolly when young, with prominent regular parallel nerves; acorns very large; islands off south coast.....8. *Q. tomentella.*

Leaves commonly 1 to 2 inches long, entire or spinose-toothed, dull green above, lead-color beneath or with a golden fuzz when young; acorn cup typically like a yellow turban; mountains.....9. *Q. chrysolepis.*

Shrubs; acorn cup subturbinate or low bowl-shaped, thin; leaves ½ to 1½ inches long.

Branches slender and pliable, forming broom-like tufts at top of stems; leaves mostly entire, no golden fuzz; high-montane.....10. *Q. vaccinifolia.*

Branches rigid, spreading; leaves dentate-prickly, olivaceous above, pale beneath; Southern and Lower California..11. *Q. palmeri.*

Black Oaks—Bark dark or black, wood dark or reddish; stamens mostly 4 to 6; stigmas on long styles; abortive ovules mostly towards base of nut; nut tomentose within.

Acorns ripe in first autumn; nut slender-ovate; leaves roundish or elliptic, convex above; coast valleys and hills.....12. *Q. agrifolia.*

Acorns ripe in second autumn.

Leaves oblong, obtuse or tapering to the acute apex, plane, pale-yellowish below; nut slender-ovate, often streaked longitudinally; interior valleys and hills.....13. *Q. wislizenii.*

Leaves pinnately parted, the divisions lobed and bristle-tipped; nut oblong, obtuse; mountains.....14. *Q. kelloggii.*

Valley Oak.

1. QUERCUS LOBATA Neé. Figs. 85 and 28.

Leaves 3 to 4 (rarely 6) inches long, 2 to 3 inches wide, green above, paler beneath with a thin but close covering of short hairs, yellow-veined, pinnately parted to the middle or nearly to the midrib into 3 to 5 pairs of lobes; lobes most commonly broadened towards the end, less frequently pointed, coarsely 2 or 3-toothed at apex, or sometimes entire; acorns ripe in first autumn; cup drab-brown, with a dull reddish tint, deeply hemispherical, very warty or tuberculate, ½ to ¾ inch deep or more, of greater diameter than the nut; nut long-conical, at first bright green, later mahogany or chestnut-brown, 1½ to 2¼ inches long and ½ to ¾ inch thick.

Valley Oak, often called Weeping Oak, is a graceful tree commonly 40 to 75 feet tall with a trunk 2 to 6 feet in diameter. The round-topped crown is often broader than high, its spreading branches finally ending in long slender cord-like branchlets which sometimes sweep the ground. The bark is dark brown, sometimes ashen gray, deeply checked into small rectangular or narrow or cuboid plates.

Quercus lobata is the most characteristic tree of valley levels in the Sacramento, San Joaquin and North Coast Range

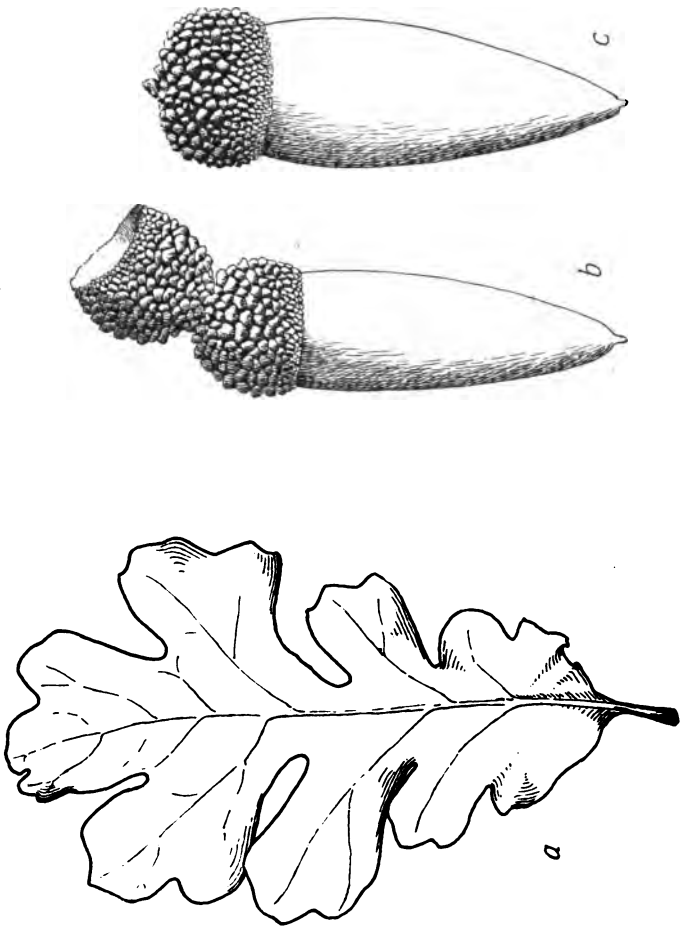

Fig. 85. Valley Oak (*Quercus lobata* Née). *a*, Typical leaf; *b*, *c*, acorns. nat. size.

valleys and of many valleys in the South Coast Ranges. It is also found in mountain valleys in the Sierra Nevada foothills up to 2,000 feet at the north and to 4,000 feet at the south. Southward it ranges from Fort Tejon through the Santa Barbara mountains to the Ojai Valley; beyond this only in a feeble way as far as San Fernando Valley.

It attains its greatest development in the deep moist loam of alluvial or delta valleys as on the Kaweah Delta in the San Joaquin, about Marysville and Chico in the Sacramento, and in some of the North Coast Range valleys. In such places individual trees not infrequently attain diameters of 8 to 10 feet and extreme heights of 100 to 150 feet. Although growing in smaller form on the clay hills, it is on the plain-like levels that one finds the most characteristic growth. Typical individuals in such stations are exceedingly satisfying and inexhaustible as tree studies. Set in clusters or scattered about singly, without associates save their own kind, they rarely crowd each other and are disposed with a taste no landscape artist could match, while the ground beneath is perfectly free from undergrowth or shrubs. The early explorers looked upon them with admiring eyes and turning one to the other compared the scene to well-kept planted grounds or to a nobleman's park.

To appreciate such landscapes one must see them from some little vantage point where he may overlook the valley floor, the groves of scattered trees and the projecting bases of the purple hills indenting irregularly the plain. Such pictures stored in the mind, recall the broad expanse of Berryessa Valley, the circle of Round Valley and of Little Lake Valley, and the well-watered fields about Clear Lake. In some regions where the horticultural development has been rapid or the needs of an increasing population urgent, extensive areas have been cleared to make room for orchards or gardens, and scarcely a tree remains to tell the story of the old-time monarchs of the soil; in other regions destruction has not been so complete. There are still fine groves in the Ukiah Valley, Napa Valley and in certain localities on the plains of the Sacramento. The valleys about the northerly base of Mt. Diablo cherish semi-primitive clusters, as do other of the inner Coast Range valleys further removed from centers of

population. Old Fort Tejon, at the head of the San Joaquin, is set in an interesting assemblage of large-sized trees.

Quercus lobata is strongly marked by its deep tuberculate cup,* long cartridge-like nuts, pinnately lobed leaves, cuboid-broken bark, and weeping sprays. These characters are very uniform throughout its range. The extreme varieties† are as follows: Var. WALTERI Jepson. Leaves roundish in outline, sinuses very narrow; nuts very thick.—Kaweah River basin at about 4,000 feet. Var. TURBINATA Jepson. Leaves large and thicker than in type; nuts turbinate.—Little Lake Valley in the North Coast Ranges.

Valley Oak is of little economic importance except as a shade tree in farming fields or as to the use made of it for fuel. Its wood is white, hard and brittle, being the least esteemed hard wood of California. While extensively used for firewood it is rarely employed for any other purpose. So frequently an inhabitant of delta lands, it is called "Water Oak," "Bottom Oak" or "Swamp Oak," while the folk-name "Mush Oak" carries with it a species of contempt and tells the story of its failure to meet the requirements of a tough strong wood in a land where good oak is scarce and dear.

Appreciation of the Valley Oak must, therefore, rest almost wholly upon sentimental grounds. The leaves do not fall until late December, but defoliation changes little the aspect of a tree which makes so slight concession to the seasons. On the rich valley levels these trees are never mistaken. Whether it be in the still summer days with jays, woodpeckers and crows noisy in their tops, in the full of the hunter's moon with their bulks rising darkly out of the white stubble fields and the delicate fragrance of the foliage filling the air, or in the blackness of winter night when the north wind is shouting across the plain and their massive branches are traced against the bright glow of tule fires in the river bottoms—at all seasons their charm is in their tall broad crowns, their story on story of tortuous branches, their graceful drooping sprays and the distinct individuality which resides in every tree. They are, as the wise first-comers well knew,

*Burr Oak is a name rarely applied to this species.

†A fuller account of the varieties in this species will be found in the author's Flora of California.

the sign of the richest soil. They tell the mettle of the land and they give the land a fine distinction.

Oregon Oak.

2. QUERCUS GARRYANA Dougl. Figs. 86 and 87.

Leaves 3 to 4 (or 6) inches long, 1½ to 4½ inches wide, dark lustrous green and nearly glabrous above, rusty or pale, finely pubescent and yellow-veined beneath, leathery in texture and parted into 5 to 7 (rarely 9) lobes with mostly deep and often acute sinuses; lobes entire or with 2 or 3 coarse rounded unequal teeth; acorns ripe in first autumn; cup very shallow, 6 to 9 lines broad, with tuberculate scales; nut bulging beyond the small cup, typically subglobose but varying to obovoid or subcylindric, although always rounded at apex, ¾ to 1 inch long, ⅔ to ¾ inch thick, its surface polished and shining.

Oregon Oak, also called Post Oak, is a tree 25 to 55 feet high with a rounded crown and trunk 1½ to 5 feet in diameter. The trunk bark is white, thin (½ inch thick), smoothish but superficially fissured into longitudinal bands which are transversely checked into small squarish scales 1 inch or less broad. It is best known by its broad spreading crowns—often broader than high, its white squarish-scaly trunk bark, mossy main arms and glossy leaves. It inhabits mountain slopes, ridges and cañons and is distributed from the Santa Cruz Mountains to Mt. Tamalpais (north slopes), and northward in the Coast Ranges through Oregon and Washington to British Columbia. In Sonoma, Mendocino and Humboldt counties it is abundant in the "Bald Hills" country inside the Redwood Belt where in company with Douglas Fir, Tan Oak and Madroña it forms extensive groves or small irregular clusters with grassy deer-parks between, free glades at the head of wooded cañons or "opens" here and there on the slopes or very summits. No other part of California offers scenes of mixed woods which equal these in interest and satisfying beauty.

In the southern Sierra Nevada from Mariposa to the Kaweah Basin this species occurs in dwarf form (Var. SEMOTA Jepson), the leaves with rather sharp sinuses. The Brewer Oak is another dwarf form (Var. BREWERI Jepson, Fig. 86c) occurring at high altitudes in the Trinity and Scott mountains and on Marble Mountain. It has small deeply lobed leaves with rounded sinuses.

The wood of Quercus garryana is hard, fairly strong, straight- and close-grained, and remarkably white. It is used

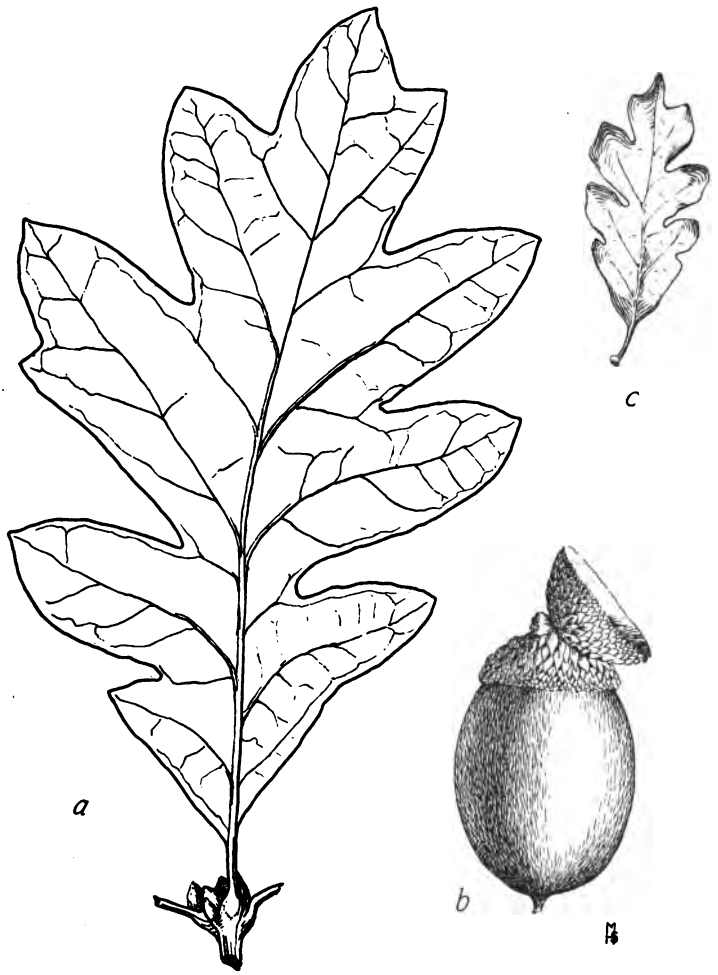

Fig. 86. OREGON OAK (*Quercus garryana* Dougl.). *a*, Leaf, the type with acutish lobes; *b*, acorn. *c*, BREWER OAK (Var. *breweri* Jepson), typical leaf. nat. size.

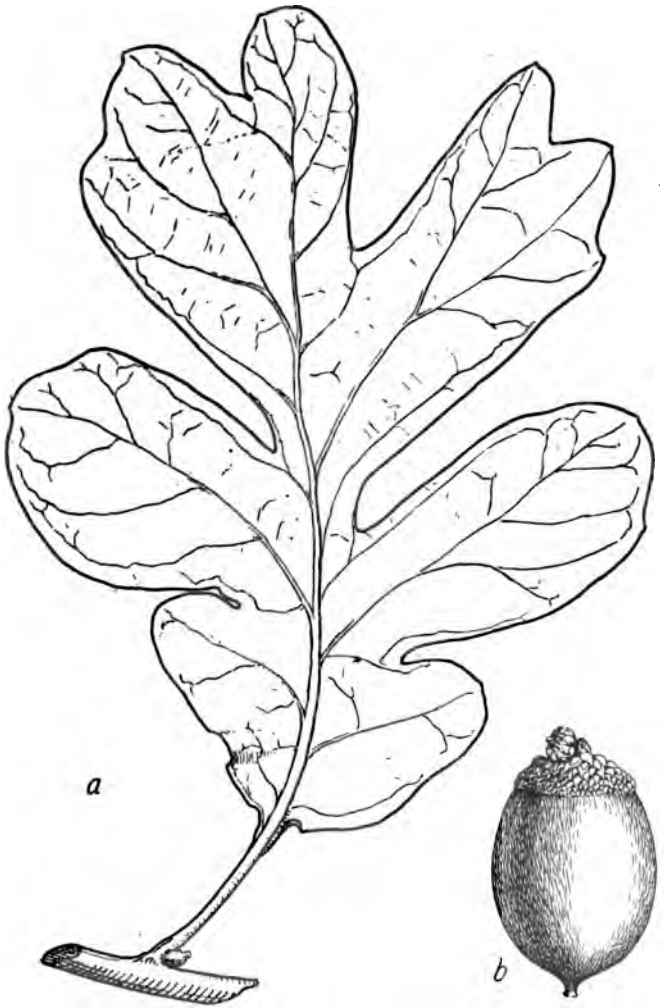

Fig. 87. OREGON OAK (*Quercus garryana* Dougl.). *a*, Leaf, the type with deep sinuses and lobes broadened towards the end; *b*, acorn. nat. size.

for fence posts and in Oregon for furniture and interior finish. It is, next to Maul Oak, the most valuable of West American oaks.

Blue Oak.

3. QUERCUS DOUGLASII H. & A. Figs. 88, 89, 31 and 30.

Leaves minutely pubescent, bluish green above, pale beneath, 1 to 3 inches long, ½ to 3 inches wide, mostly oblong to obovate, entire, or coarsely and often unequally few-toothed, or shallowly lobed; acorns ripe in first autumn; cup 4 to 6 lines broad, of less diameter than the nut and very shallow, the scales developing small wart-like processes; nut ¾ to 1½ inches long, 6 to 10 lines thick, dark or light brown, oval in outline but variable, often much swollen just below or at the middle or only on one side, or again narrow and tapering to apex.

Blue Oak, also called Mountain White Oak or Rock Oak, is a tree 20 to 60 feet high with a rounded crown and trunk

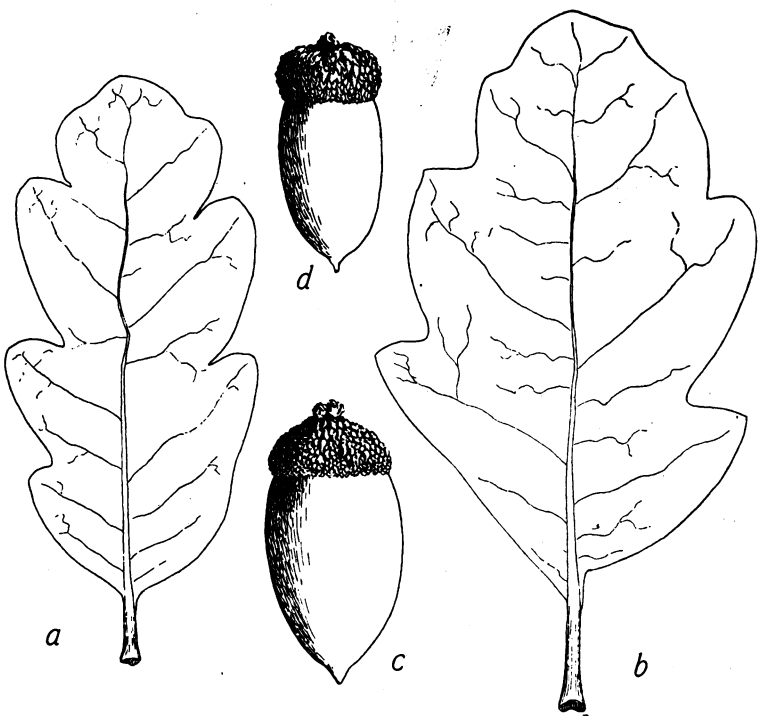

Fig. 88. BLUE OAK (*Quercus douglasii* H. & A.). *a, b,* Leaves; *c, d,* acorns. nat. size.

1 to 2 or sometimes 4 feet in diameter. The bark on the main trunk is white, shallowly checked into small thin scales; it is only slightly roughened but with the characteristic roughness extending up the limbs well onto the branches. It is most easily recognized by its white trunks and blue foliage.

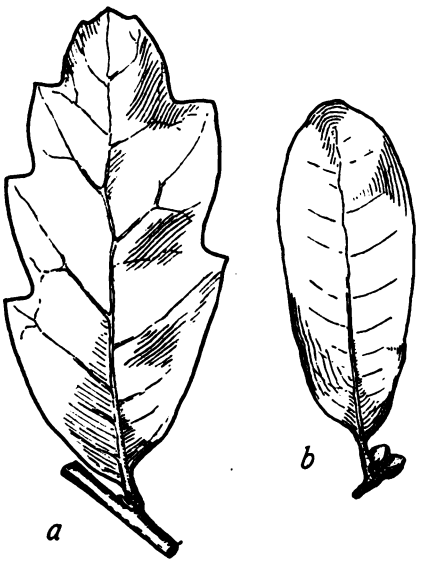

Fig. 89. BLUE OAK (*Quercus douglasii* H. & A.), types of leaves. *a*, Toothed leaf; *b*, entire leaf. nat. size.

Quercus douglasii inhabits rocky or clay hills and is widely distributed through the foothill country around the Great Valley, north to the upper Sacramento and south to Fort Tejon. South of Tejon it occurs locally in the Sierra Liebre and in San Fernando Valley. In the Sierra Nevada foothills it is the most characteristic oak between 300 and 1,500 feet at the north and 500 to 2,500 or rarely 4,000 feet at the south, forming groves of much-scattered trees and usually growing by itself, although often associated with Digger Pine and Interior Live Oak. In the Coast Ranges it is common in the inner and middle ranges, extending west to but not entering the Redwood Belt and also avoiding the North Coast Range mountains of higher altitudes.

Its wood is close-grained, hard and brittle. Sometimes heartwood is so dense and hard that it will turn the edge of an axe, whence the settlers' name, Iron Oak. It is extensively used for firewood or occasionally for tool-handles. The acorns provide irregular crops as feed for hogs.

"Not in itself an attractive tree the Blue Oak by reason of its form, color, and habit plays a strong and natural part in

the scenery of the yellow-brown foothills. Always scattered about singly or in open groves, the trees are well associated in memory with bleached grass, glaring sunlight and dusty trails, although for a few brief days at the end of the rainy season the white trunks rise everywhere from a many-colored cloth woven from the slender threads of innumerable millions of flowering annuals."*

Mesa Oak.

4. QUERCUS ENGELMANII Greene.

Leaves blue-green, oblong, obtuse, entire or sometimes toothed, ¾ to 3 (most commonly 1¼ to 1¾) inches long, ⅝ to 1 inch wide; acorns ripe in first autumn; cup ¾ inch broad, shallow or sometimes bowl-shaped, with warty scales, enclosing nearly ½ the nut which is sub-cylindrical, ½ inch long and about as thick, or 1 inch long, relatively less thick and sometimes acute.

Mesa Oak is a spreading or round-crowned tree 15 to 40 feet high with trunk ½ to 2 feet in diameter. It is often called Evergreen White Oak because the leaves persist through the winter until the new leaves burst in the spring. It inhabits the low hills at about 15 or 20 miles from the ocean, extending from the southern slopes of the Sierra Madre southward to San Diego County, and crossing the Mexican boundary into adjacent Lower California.

5. **Quercus dumosa** Nutt. SCRUB OAK. (Fig. 90.) Shrub 2 to 5 or 8 feet high, with tough rigid branches and branchlets; leaves typically oblong to elliptic or roundish, entire or more commonly irregularly spinose-serrate, or sinuate-lobed with sharply cut or angular sinuses, ¾ to 1 inch long; acorns ripe in first autumn; cup shallowly or deeply saucer-shaped to turbinate, 5 to 8 lines broad, 2 to 5 lines deep, often rusty, the scales tuberculate, sometimes so regularly as to suggest a quilted cushion; nut oval to cylindric, rounded or pointed at apex, ¾ to 1⅛ inches long.—Common chaparral shrub in the mountains of Southern California, extending south into Lower California and ranging northward through both the Coast Ranges and Sierra Nevada, more or less abundant in the middle and southerly parts of those ranges, rarer in the north. Highly variable in leaf texture and outline and in acorn character, both of cup and nut. Grey Oak is a variety (Var. TURBINATA Jepson) with

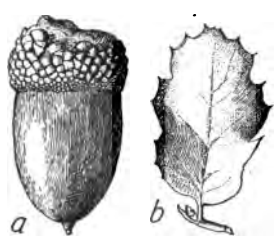

Fig. 90. SCRUB OAK (*Quercus dumosa* Nutt.). *a*, Acorn; *b*, leaf. nat. size.

*Jepson, Silva of California, Memoirs, Univ. Cal., No. 2.

pale brittle leaves, small turbinate cups and slender pointed acorns which occurs from the San Carlos Range to Lower California. Brittle-leaf Oak is another marked variety (Var. ALVORDIANA Jepson) with similar leaves and very long slender nuts. It occurs in the inner South Coast Range from Cantua Creek to the San Emigdio Mountains.*

6. **Quercus durata** Jepson. LEATHER OAK. Low spreading shrub with rigid branches, 2 to 5 feet high; younger branches and leaves densely tomentose; leaves oval, dentate with prickly equal teeth, above convex, the margin more or less revolute; acorns ripe in first autumn; cup bowl-shaped, 8 to 9 lines broad, 4 to 5 lines high, scales tuberculate; nut short, thick, cylindric, rounded at apex, 7 to 9 lines long.—San Carlos Range and probably general in Coast Ranges in more or less typical form.

7. **Quercus sadleriana** R. Br. Campst. DEER OAK. Shrub mostly 2 or 3 but even 8 feet high with several stems from the base; leaves persistent through the winter and until after the new leaves appear in the next summer, oblong-ovate to broadly ovate, 3 to 4½ inches long, the lateral nerves prominent, regular and parallel; stipules oblanceolate, ½ to ¾ inch long, fur-like on account of their dense covering of rusty hairs and persisting as long or even longer than the leaves; acorns ripe in first autumn; cup enclosing about ⅓ of the nut which is oval and about ¾ inch long.—High-montane, (5,000 to 7,000 feet); Trinity Summit to Marble Mountain, west to the Klamath Range, north to the Siskiyou Mountains and into southwestern Oregon. Most restricted in range of any Californian mainland oak.

Island Oak.

8. QUERCUS TOMENTELLA Engelm.

Leaves elliptic to oblong, light green above, paler beneath and densely fulvous-tomentose when young, more or less glabrate in age, 2 to 3½ inches long, ¾ to 1¾ inches wide; nerves regular, parallel and very strong beneath, ending in the teeth of the margin, or the margin sometimes entire; acorns ripe in second autumn; cup 1 to 1½ inches wide, ½ to ¾ inch deep, its scales concealed by a dense tomentum, the elongated tips quite free; nut subglobose with a short bluntish point, about 1 inch long.

Island Oak is a tree 25 to 55 feet high with roundish crown and trunk 1 to 2 feet in diameter. The bark is gray-brown, smoothish, with irregular flattish ridges separated by longitudinal fissures. It is a strictly insular species, first discovered on Guadalupe Island and since found on Santa Cruz, Santa Rosa, San Clemente and Santa Catalina islands. On Santa Catalina Island I saw only trees that had been derived from stump-sprouts—slender poles 40 to 55 feet high in clusters of 3 to 10 with diameters of 1½ to 2 feet. Quercus

*cf. *Jepson, Flora* of California.

tomentella is the rarest in individuals of all West American oaks. It is scarcely more than a subspecies of Quercus chrysolepis but is remarkable for its tomentose leaves and the size of its acorn cups.

Maul Oak.

9. QUERCUS CHRYSOLEPIS Liebm. Fig. 91.

Leaves 1 to 2 (sometimes even 4) inches long, thick, green above, yellow beneath with a fine fuzz or powder, or eventually lead-color or dull white, ovate or oblong-ovate, acute at apex, entire, or with entire and toothed leaves frequently found on the same twig; acorns ripe in second autumn; typical cup thick and round-edged with a fine fuzzy or

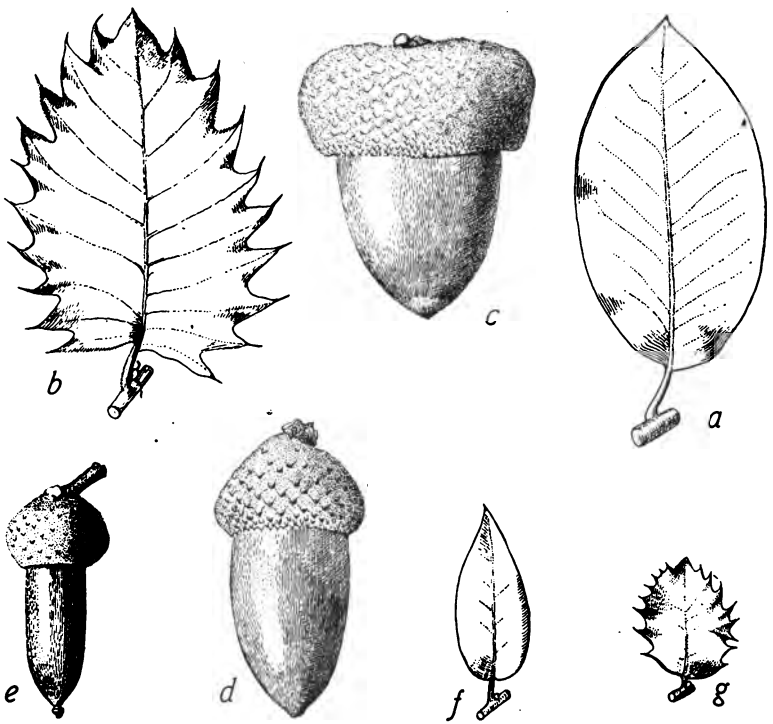

Fig. 91. MAUL OAK (*Quercus chrysolepis* Liebm.); *a*, entire leaf; *b*, toothed leaf; *g*, small toothed leaf typical of stump-sprouts; *c*, acorn with turban-like cup. *d*, TALL CAÑON OAK (Forma *grandis* Jepson), acorn. *e*, HANSEN OAK (Forma *hansenii* Jepson), acorn. *f*, DWARF MAUL OAK (Forma *nana* Jepson), leaf. nat. size.

felt-like tomentum concealing the scales, the whole suggesting a yellow turban, but thinnish cups and scanty pubescence not concealing the scales occur as frequently; nut ovate, globose, or cylindric, rounded at apex or sharply pointed, 1 to 1¼ inches long, ¾ to 1 inch thick.

Maul Oak is a tree 15 to 60 feet high with roundish, often spreading crown and trunk 1 to 5 feet in diameter. On high ridges or exposed mountain summits it is often reduced to a mere shrub a few feet high. Whitish bark, small entire and toothed leaves on same twig, old leaves lead-color beneath and young leaves yellow-powdery beneath, acorns with turban-like cups—these are the most striking characteristics of Maul Oak and by means of which it may most readily be recognized.

Quercus chrysolepis inhabits fertile mountain slopes or shoulders, dry rocky ridges, moist protected cañon sides and valley floors and is widely distributed throughout the State both horizontally and vertically. In the Sierra Nevada it occurs chiefly between 1,500 and 5,000 feet at the north and 3,000 and 8,000 feet at the south, mainly on cañon slopes where it is a low spreading tree often forming the main part of the cover. In Hetch-Hetchy, Yosemite, Kings and Kern, round balls of Maul Oak are a feature of the rocky walls and talus. In the Coast Ranges it is confined for the most part to the higher ranges and reaches its greatest development in Mendocino and Humboldt counties where large-sized broad-crowned trees dignify little shoulders on mountain slopes in the Bald Hills country* or inhabit valley floors as in Hupa Valley. The tallest trees, that is those characterized by tall trunks and comparatively small crowns, grow on the sharp walls of deep cool cañons. The finest examples known to the author inhabit Mill Creek Cañon near Ukiah, where fortunately the trees are protected in State property.

In Southern California it is common at 2,000 to 6,000 feet in the Sierra Madre, San Bernardino and San Jacinto mountains, ranging south into Lower California and eastward to New Mexico. It also occurs in southern Oregon.

Its wood is remarkable among Californian oaks for its strength, toughness and close grain. It seasons well, is almost

*Along the Blue Rock Ridge in Humboldt County the author has measured not a few trees 60 to 80 feet high, 70 to 100 feet across the crown *and 3 feet in trunk* diameter.

as heavy dry as green, and is used for mauls, wagon parts, tool-handles, ship's knees, furniture and floors.

On account of the wide use of Maul Oak by settlers, mill men and mountain packers no other Californian oak has so many folk-names in use. Being evergreen it is called Mountain Live Oak, or merely Live Oak, especially in those regions where it is the only Live Oak; in other places it is termed Cañon Oak, Drooping Oak, or White Live Oak since it is one of the White Oaks. Woodsmen frequently know it as Spanish Oak, Valparaiso Oak, Georgia Oak, and Florida Oak. On account of the pollen-like powder on the under side of the younger leaves or on the cup, it is famed as Gold-leaf Oak, Gold-cup Oak or Golden Oak, while certain shapes of the leaves explain the term "Laurel Oak." "Iron Oak," "Pin Oak," and "Hickory Oak" are names which, like Maul Oak, speak the respect of the ranch man for its wood.

Maul Oak is exceedingly variable in all its characteristics. The crown may be very tall and broad in the open, narrow with tall trunks in cañons, or with very low broad crowns and exceedingly short trunks on arid slopes. The leaves are very variable, especially as to the margins. Variability is also a marked characteristic of both acorn cups and nuts. Coloration is a convenient means of recognizing the tree as indicated above. Some of the more striking variations in leaves and acorns are shown in Fig. 91. These forms are more fully described in the author's Flora of California.

10. **Quercus vaccinifolia** Engelm. HUCKLEBERRY OAK. (Fig. 92.) Shrub, prostrate, or erect and 2 to 6 feet high, the slender pliable branchlets in tufts at top of stems, simulating the habit of a huckleberry; leaves oblong-ovate, mostly obtusish or only sub-acute, commonly entire, pale green above, often tan-color beneath, mostly ¾ to 1⅛ inches long or less; acorns ripe in second autumn; cup broadly turbinate or shallowly bowl-shaped, thinnish, not fulvous-tomentose but merely pubescent, 3 to 4 lines broad; nut globose-ovate, rather abruptly drawn down to a sharp point, 4 to 6 lines long, 4 to 5 lines thick. — High-montane rocky slopes and summits, 5,000 to 10,000 feet, central and northern Sierra Nevada, west to Mt. Shasta, and in the far North Coast Ranges from Trinity Summit to Marble Mountain and the Siskiyous. Often gregarious. No more than a subspecies of

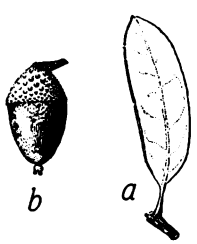

Fig. 92. HUCKLEBERRY OAK (*Quercus vaccinifolia* Engelm.). *a*, Leaf; *b*, acorn. nat. size.

Quercus chrysolepis and often passing into it; yet in its ordinary form Huckleberry Oak is remarkably different from Maul Oak, occupies an entirely distinct area and is, in consequence, of real taxonomic and geographic importance.

11. **Quercus palmeri** Engelm. PALMER OAK. Rigidly branched shrub 5 to 15 feet high; leaves typically elliptic to roundish ovate or nearly orbicular, wavy-spinose, ½ to 1½ inches long, undulate, coriaceous and stiff, olivaceous above, pale or whitish beneath; young leaves sparingly pubescent on the upper surface and with a dense but thin yellowish or later white felt on the lower surface; acorns ripe in second autumn; cup thinnish, sub-turbinate but shallow, 5 to 7 lines broad, 3 to 5 lines deep; nut ovate, ¾ to 1 inch long, the shell tomentose within; seed-leaves purple, separable.—Mountains of Southern California from Vandeventer Ranch in the San Jacinto Range southward into Lower California.

Coast Live Oak.

12. QUERCUS AGRIFOLIA Neé. Figs. 93, 94 and 34.

Leaves roundish, elliptic, sometimes ovate or oblong, usually with spine-tipped teeth or sometimes entire, commonly 1 or 2 inches long but varying from ½ to 4 inches and usually convex above; staminate catkins 1 to 1½ inches long, deep red; acorns ripe in first autumn; cup broadly turbinate, 4 to 7 lines deep, usually embracing only the base of the nut; nut slender, pointed, 1 to 1½ inches long, 5 to 7 lines thick.

Coast Live Oak, called simply Live Oak, is a low broad-headed tree commonly 20 to 40 but sometimes 70 feet high. The trunk is 1 to 4 feet in diameter, usually short and parting into wide-spreading limbs which often touch or trail along the ground. The trunk bark is smooth and beech-like, sometimes irregularly fissured or with an occasional very deep fissure, dark brown or gray on the surface, reddish or pink inside, very brittle when fresh, 1 to 2¼ inches thick.

Quercus agrifolia grows on rich valley floors, rocky hills, fertile slopes or benches in the hills, or on dry mesas. It is distributed in the North Coast Ranges from northern Sonoma County to Marin and to Suisun Valley, and throughout the South Coast Ranges, where it is very abundant and widely scattered, to Southern and Lower California.

It is a hardy tree and is often the only tree which inhabits outlying or wind-swept stations in the South Coast Range country. It accommodates itself to such places as wind-gaps in the hills by developing its crown to leeward or on the exposed ridges (Fig. 21) by developing horizontally over the ground. As an indicator of the prevalence and velocity of the trade winds

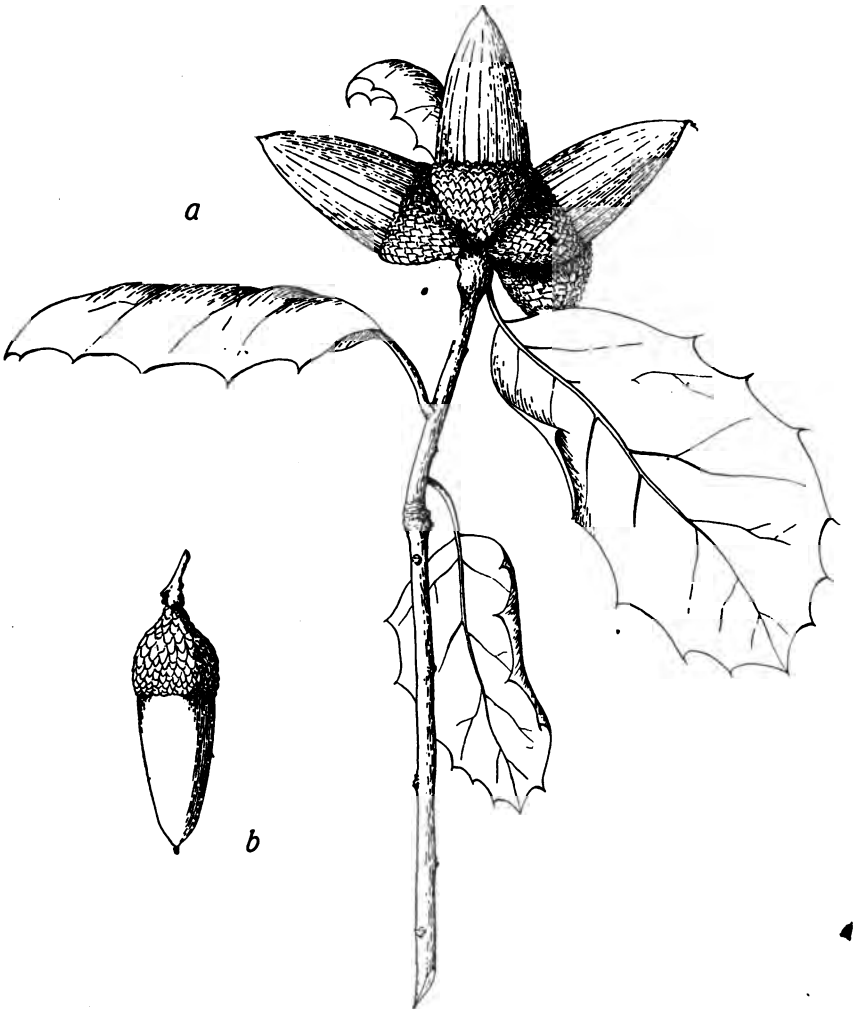

Fig. 93. Coast Live Oak (*Quercus agrifolia* Neé.). *a*, Acorn-bearing branch; *b*, the most common type of acorn. nat. size.

in a particular locality no other tree gives such sure testimony. Some fine examples of crowns developed wholly to one side of the trunk may be seen between Carmel and Pescadero Point on the Seventeen Mile Drive.

Its wood is hard, heavy and moderately strong, is extensively converted into firewood and charcoal, and has been used for ships' knees and wagon parts. In a continued succession of drought years branches for browsing are cut from the trees to save range cattle from starvation.

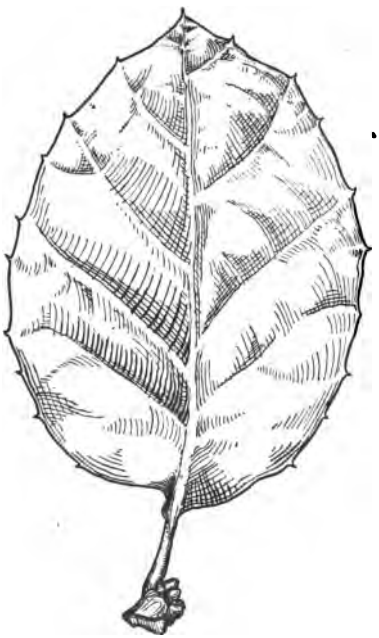

Fig 94. Coast Live Oak, usual convex type of leaf. nat. size.

This species, of inferior timber value, is undoubtedly of most economic importance to the community in an indirect way, that is in its relation to the heightened landscape effect of valleys and hills in a region which would in the main, save for it, be treeless and desolate. For throughout the coast region, except in the extreme north, this Live Oak is the most common and characteristic tree of the Coast Range valleys which it beautifies with low broad heads whose rounded outlines are repeated in the soft curves of the foothills. Disposed in open groves along the bases of low hills, fringing the rich valley lands along creeks, or scattered by hundreds or thousands over the fertile valley floors, these trees were of signal interest to the first pioneers; and so the eyes of the early Spanish explorers dwelt on the thick foliage of the swelling crowns and read the fertility of the land in these evergreen oaks which they called Encina. The chain of Franciscan Missions corresponded closely to the general range

of the Live Oak although uniformly well within the margin of its geographical limits both eastward and northward. The vast assemblage of oaks in the Santa Clara Valley met the eye of Portola, discoverer of San Francisco Bay, in 1769, and a few years later, Crespi, in the narrative of the expedition of 1772, called the valley the "Plain of Oaks of the Port of San Francisco." Then came Vancouver, Englishman and discoverer. Although he was the first to express a just estimate of the Bay of San Francisco, which he declared to be as fine as any port in the world, nevertheless it is in his felicitous and appreciative description of the groves of oaks, the fertile soil (of which they were a sign), and the equable climate that one reads between his lines of 1792 the prophecy of California's later empire.

Interior Live Oak.

13. QUERCUS WISLIZENII A. DC. Figs. 95 and 30.

Leaves typically oblong (varying to elliptic, ovate or ovate-lanceolate), either tapering to apex or rounded, 1 to 2½ (or 4) inches

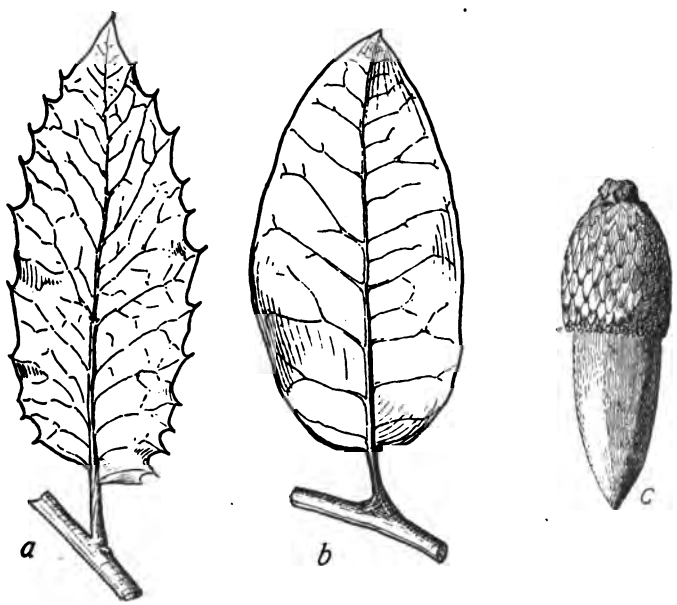

Fig. 95. INTERIOR LIVE OAK (*Quercus wislizenii* A.DC.). *a*, Typical spiny leaf; *b*, typical entire leaf; *c*, acorn. nat. size.

long, entire or spiny-toothed, green and shining above, pale yellowish green below; acorns ripe in second autumn; cup deeply cup-shaped to hemispherical, embracing ¼ to ½ the nut, 6 or 7 lines broad, composed of thin red-brown scales; nut cylindric and tapering to the apex or conical, often longitudinally banded with dark lines converging at the summit, 1¼ to 1⅝ inches long.

Interior Live Oak, called simply Live Oak, is a tree 30 to 75 feet high with full rounded crown and trunk 1 to 3 feet in diameter. The trunk bark is dark, very smooth or sometimes roughly fissured. A characteristic feature is the density of the periphery of the crown due to the abundant twigs and foliage.

Quercus wislizenii inhabits rich valley floors, clay hills, rocky slopes or ridges, and is widely distributed through the Sacramento and San Joaquin valleys, especially on the east side, extending into the Sierra Nevada foothills to altitudes of 2,000 feet at the north and 4,000 feet at the south. It also occurs in the inner North Coast Ranges, extending west to the Ukiah Valley. In shrub form (Var. FRUTESCENS Engelm.) it is found in the chaparral as a rigidly branched shrub with small leathery leaves, and occurs throughout the same general region as Coast Live Oak but only on the tops of the mountains. A form with small cylindrical nuts occurs in the Kaweah River basin at 4,000 feet altitude (Forma EXTIMA Jepson. Fig. 96).

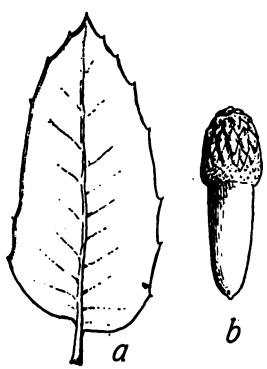

Fig. 96. PENCIL-NUT LIVE OAK. (Forma *extima* Jepson). *a*, Leaf; *b*, acorn. nat. size.

The wood of Interior Live Oak is tough and strong but is seldom used except for firewood for which it has a high fuel value. It rots quickly in contact with soil.

The areas of best development are the broad alluvial banks of rivers on the east side of the Great Valley, such as the American, Consumnes, Mokelumne, Stanislaus and Tuolumne. Typical trees in this valley region have numerous branches, erect in the top and spreading around the sides and down to the ground so as to conceal the trunk, the crown thus

resting on the ground like a great globose ball with a segment cut off the lower side. Such full and regular figures, with the flowering prairies between, provoked the unreserved admiration of the early explorers in days when the scene was further enhanced by herds both of elk and of antelope.

California Black Oak.

14. QUERCUS KELLOGGII Newb. *Q. californica* Cooper. Figs. 97, 25 and 2.

Leaves deeply and mostly sinuately parted with about 3 lobes on each side ending in 1 to 3 or more coarse bristle-tipped teeth, lustrous green above, lighter beneath, often white with a fine tomentum when young, 4 to 10 inches long and 2½ to 6 inches wide; acorns ripe in second autumn (early in the second summer nuts completely covered by the cups, forming globose knobs about ½ inch in diameter); cup large, ¾ to 1 inch deep, ¾ to 1⅛ inches broad, its scales thin, with a membranous and sometimes ragged margin; nut deeply set in the cup, typically oblong in outline, rounded at apex, 1 to 1¼ inches long and ¾ inch thick, covered at first with a fine fuzz.

California Black Oak, simply called Black Oak in the field, is a graceful tree 30 to 85 feet high with broad rounded crown and trunk 1 to 4½ feet in diameter. The bark is dark or black, on old trunks deeply checked into small plates.

Quercus kelloggii grows on high ridges, mountain slopes and in gravelly mountain valleys and is widely distributed through the Coast Ranges and Sierra Nevada, north to central Oregon, south to the high mountains of Southern California (Sierra Madre, San Bernardino, San Jacinto, Palomar and Cuyamaca mountains). In the Sierra Nevada it is most common within or just below the lower margin of the Yellow Pine Belt at 1,500 to 3,000 feet at the north and 4,000 to 6,000 feet at the south. In the Coast Ranges it occurs chiefly between 200 and 4,000 feet but its distribution is very scattering except in the higher North Coast Ranges of Mendocino and Humboldt inside the Redwood Belt. It does not associate with Redwood and is not found near the sea nor usually on valley floors, except in such valleys as Santa Rosa, Napa or Ukiah where there are locally favorable spots of clay or gravelly soil. It is a most constant associate of Yellow Pine in the Coast Ranges and is commonly found with Oregon Oak, Tan Oak and Madroña. Black Oak, however, occurs in ranges where all of these species are absent, save rarely an isolated Madroña, as in the Vaca Mountains and on Mt. Diablo.

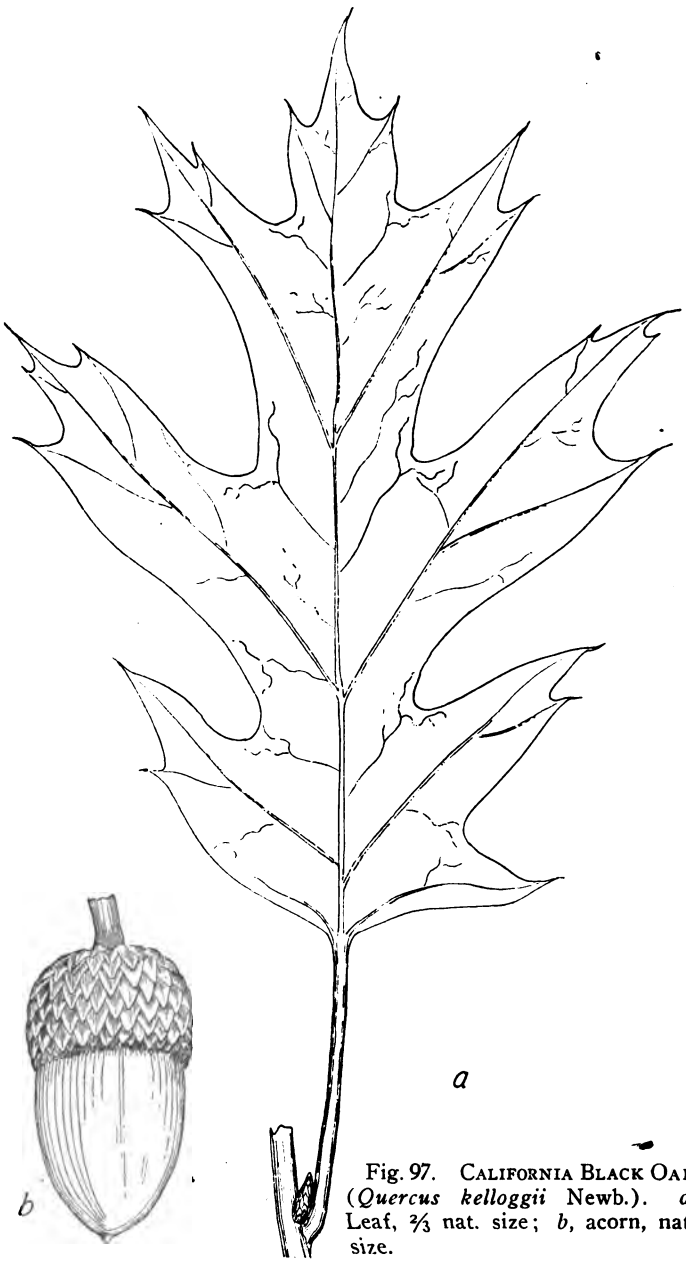

Fig. 97. California Black Oak (*Quercus kelloggii* Newb.). *a*, Leaf, ⅔ nat. size; *b*, acorn, nat. size.

The wood is heavy, hard and brittle. It is used for firewood and sometimes for wagon parts by rural artisans. Ranchmen also use it for posts but its length of life, 4 to 8 years, makes it an inferior wood for such a purpose.

Quercus morehus Kell. MOREHUS OAK. Tree 25 to 50 feet high; leaves oblong to elliptic, 2½ to 4 inches long, sinuately but rather shallowly lobed, the lobes pointing upward and spinose-tipped; cups similar to those of Quercus wislizenii or more cup-shaped; nuts cylindric, about 1 inch long, 6 or 7 lines thick, minutely pubescent.—Occasional throughout the Sierra Nevada, 2,500 to 5,000 feet; Napa Range; Mayacamas Range; seaward Coast Range from Walker Valley to Mt. Tamalpais. Here considered as a hybrid between Q. kelloggii and Q. wislizenii. (Q. morehus Kellogg, Proc. Cal. Acad. vol. 2, p. 36,—1863; Greene, West Am. Oaks, pp. 3, 79, t. 2,—1889; Sudworth, Trees Pac. Slope, p. 311,—1908).

2. PASANIA Miq. TAN OAK.

Trees or shrubs with evergreen leaves and erect catkins. Staminate flowers one in a place, densely disposed in elongated simple catkins; stamens 8 to 10, 4 times as long as the 5-parted calyx. Pistillate flowers 1 in an involucre, the involucres few at the base of some of the staminate catkins; calyx often with rudimentary stamens; ovary 3-celled. Fruit an acorn, the cup with slender spreading scales.—Pasania (native name of one of the species in Java), a genus equally related to Quercus (the oaks) and Castanea (the chestnuts), is represented by one species in California and Oregon and by nearly one hundred in southern Asia and the Malay Archipelago. Both Quercus and Castanea are ancient types geologically and Pasania is of great interest as a connecting genus which has also survived to the present day.

Tan Oak.

1. PASANIA DENSIFLORA Oerst. *Quercus densiflora,* H. & A. Figs. 98, 99 and 24.

Leaves oblong, acute, strongly parallel-nerved beneath, the nerves ending in the teeth of the margin, 2½ to 4½ inches long, 1 to 1¾ inches wide; catkins slender, 2 to 4 inches long; acorns ripe in second autumn; cup including the spreading scales ¾ to 1¼ inches broad; nut globose or short thick cylindric, rarely ovoid and acute, 1 to 1½ inches long, covered with a deciduous close woolly coat.

Tan Oak is a large tree, 50 to 150 feet high, in the open with broad crown rounded at summit, in dense forest with narrow pointed crown, the trunk 1 to 4 feet in diameter. It

Fig. 98. TAN OAK *(Pasania densiflora* Oerst.). Flowering branchlet, the catkins staminate or some of them with pistillate flowers at base. ½ nat. size.

inhabits fertile mountain slopes and ridges and is distributed through the seaward Coast Ranges from near Nordhoff north to Del Norte County and the Umpqua River in Oregon. In the North Coast Ranges it extends eastward to the Napa Range, Cobb Mountain, South Fork Mountain and New River. In the Sierra Nevada it occurs sparingly and in isolated localities from Lassen Peak to Mariposa County.

It is highly valued for its bark which is consumed in large quantities (about 25,000 cords annually) by the California heavy leather tanneries. After the bark is stripped from the felled trees, about 100,000 trunks 10 to 100 feet long and ½ to 4 feet in diameter are left annually to rot on the ground, saving a small percentage, say 5 per cent. which is cut into firewood. It is believed that the wood has a high potential value but commercial utilization is delayed because methods of handling it to the highest advantage have not as yet been discovered.

Fig. 99. TAN OAK acorns. *a*, Pointed nut; *b*, *c*, the usual type of nut. nat. size.

Scrub Tan Oak, a low shrub 1 to 10 feet high, is a variety (Var. ECHINOIDES Sarg.) with thick entire leaves (1 to 2 inches long, the nerves inconspicuous), very bur-like cups and small roundish nuts. It occurs from near Mt. Shasta west to the Siskiyou and Klamath ranges; also in Mariposa County.

3. CASTANOPSIS Spach. CHINQUAPIN.

Evergreen trees or shrubs. Catkins slender, erect. Staminate flowers in clusters of 3, disposed on elongated simple or sometimes branching catkins; calyx 5 or 6-parted; stamens 10 or 12; ovary rudiment present. Pistillate flowers 1 to 3 in an involucre, the involucres on shorter catkins or sometimes scattered at the base of the staminate catkins; calyx 6-cleft with abortive stamens on its lobes; ovary 3-celled with 2 ovules in each cell; styles 3. Fruit ripe in second autumn, the spiny bur-like involucre enclosing 1 to 3 nuts. Nuts ovoid or globose, more or less angled, usually 1-seeded.—Two species on the Pacific Coast of North America and about 25 in southeastern Asia. (Greek kastanea, chestnut, and opsis, resemblance.)

Tree with thick rough bark, less commonly a shrub; leaves 2½ to 5½ inches long, usually long-pointed.....1. *C. chrysophylla.*

Shrub, low and spreading, with thin bark; leaves 1½ to 3 inches long, usually obtuse .....2. *C. sempervirens.*

Giant Chinquapin.

1. CASTANOPSIS CHRYSOPHYLLA A. DC.

Leaves oblong, tapering to base and also to the apex (commonly abruptly long-pointed), entire, dark green on the upper surface, at first golden with a fine tomentum below, later light olive-yellow, 2½ to 5½ inches long, ¾ to 1¾ inches wide, nerves straightish, forking well inside the margin; staminate catkins simple or branching, 1 to 4 inches long, borne in clusters at the ends of the branches; involucres borne in shorter simple catkins or sometimes scattered at the base of the staminate catkins; burs chestnutlike, irregularly 4-valved, containing 1 or sometimes 2 subtriangular nuts 4 or 5 lines long with hard shell and sweet kernel.

Giant Chinquapin is a forest tree 50 to 115 feet high with narrow pointed or in age rounded crown and tall trunks 2 to 6 feet in diameter. The bark is brown or dull gray on the surface, reddish inside, very fibrous, 1 to 3 inches thick and separated by deep longitudinal furrows into heavy rounded sparingly confluent ridges.

Castanopsis chrysophylla inhabits the deep soil of mountain ridges or slopes as an associate of the Redwood and is distributed from central Mendocino County, where it reaches its greatest development, northward to the Oregon Cascades. It is often called "Chestnut", and sometimes "Red *Oak" or* "Bur Oak" in the Mendocino woods.

"Golden Chinquapin" (Var. MINOR Benth.) is a shrub form with trough-like leaves very golden on the under surface. It ranges from Monterey and the Santa Cruz Mountains northward to Mendocino and Humboldt, growing chiefly on rocky slopes or ridges.

Giant Chinquapin in its largest form is a rare tree of the Mendocino woods, the individuals of large size being scattered at wide intervals in the Redwood forest. Its wood is reddish brown with white sapwood, close- and straight-grained and takes a glossy finish. It is rarely used for any fine purpose but is sometimes cut for fuel. The bark parts very readily from the wood and is used to adulterate Tan Oak bark, the fine logs being left to rot on the ground. This practice is all the more reprehensible in that the bark has no value for tanning purposes.

2. **Castanopsis sempervirens** Dudley. BUSH CHINQUAPIN. Spreading shrub 1 to 8 feet high with smooth brown bark; leaves oblong, acutish at base, acute or obtuse at apex, or sometimes tapering upwards from near the base and therefore lanceolate-oblong, 1½ to 3 inches long and 5 to 11 lines wide; catkins simple, 1 to 1½ inches long, 5 to 20 in a rather dense terminal cluster, the upper with pistillate flowers at base.—Arid mountain slopes or rocky ridges, Sierra Nevada (3,000 to 8,000 feet), Coast Ranges (1,500 to 4,000 feet), Sierra Madre, San Bernardino and San Jacinto ranges (8,500 to 10,000 feet); also on Mt. Shasta.

PLATANACEAE. PLANE FAMILY.

Large deciduous trees with alternate ample palmately lobed leaves and sheathing stipules; dilated base of petiole enclosing the bud of the next season; bark falling away in thin plates. Flowers monoecious, the staminate and the pistillate on separate axes, closely packed in separate ball-like clusters distributed at intervals along a terminal very slender axis, the inflorescence thus appearing moniliform. Receptacles very hairy and individual flowers difficult to segregate, the staminate probably of 1 to 3 stamens and the pistillate of 6 to 9 pistils. Sepals or petals none. Stamens with long anthers and very short filaments densely crowded on a globose fleshy receptacle. Pistils with interspersed clavate truncate bracts, crowded on a similar receptacle; ovary 1-ovuled; style one, filiform, laterally stigmatic. Fruit a coriaceous nutlet with tawny hairs about the base.

1. **PLATANUS** L. PLANE.

The only genus. About 4 species and 5 varieties. The Old World Plane, P. orientalis, is cultivated as a street tree. (Greek platus, broad, in reference to the leaves.)

Western Sycamore.

1. PLATANUS RACEMOSA Nutt. Figs. 100 and 101.

Leaves commonly broader than long, 4 to 12 (or 20) inches broad, 3½ to 9 (or 13) inches long, parted into 3 to 5 broad spreading fingers

Fig. 100. WESTERN SYCAMORE (*Platanus racemosa* Nutt.). Branchlet *with string of* balls. ⅓ nat. size.

or lobes, the lateral ones smaller or much reduced; margin entire or with few small teeth; petioles ½ to 1¾ inches long, the expanded base covering the bud of the next season; stipules very conspicuous when full grown, roundish or angular in outline and encircling or sheathing the stem; ball-like flower clusters, 2 to 7 in number, distributed at intervals along pendulous and very slender axis borne at or near the end of a branch; balls falling to pieces in the winter, releasing the seed-like nutlets.

Western Sycamore is a tree 40 to 90 feet high with a massive crown of wide-spreading limbs supported on a trunk 1 to 5 feet in diameter. The bark is smooth but exfoliates thin reddish brown plates which expose greenish or whitish areas and give the trunk a mottled appearance.

Platanus racemosa is most characteristic of stream bottoms, either constant or summer-dry, in the more arid parts of California between the desert and the areas of high precipitation. It is most abundant in the South Coast Ranges but does not extend into the desert. On the other hand it does not enter the summer fog belt and it has never been seen in the North Coast Ranges. It ranges south through Southern California to Lower California and northward through the Sierra Ne-

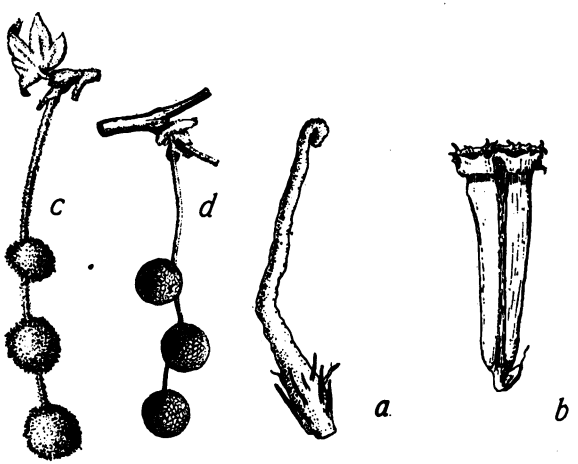

Fig. 101. WESTERN SYCAMORE, capitate clusters of flowers spaced along a pendulous axis. *d*, Staminate inflorescence; *c*, pistillate inflorescence; *a*, pistil; *b*, stamen. *c* and *d*, nat. size; *a* and *b*, 12 times enlarged.

vada foothills, San Joaquin and Sacramento valleys as far north as Anderson, Tehama County.

Sycamore is often, especially in the South Coast Ranges and in Southern California, the only tree in its locality. Thin groves on alluvial benches or in river bottoms are remarkable for their leaning trunks which have diverged from the perpendicular by reason of the shifting nature of soil in stream beds. On account of its large irregular crown, the long reach of its branches, its ample foliage turning bronze-color in late autumn, its leafy light-gray bark and handsome strings of balls, Sycamore holds the attention of the traveler in the characteristic country which it favors and takes a permanent place in his interest.

LAURACEAE. LAUREL FAMILY.

Aromatic evergreen trees and shrubs. Leaves alternate, simple, entire, without stipules. Flowers perfect and regular. Petals none. Anthers opening by uplifted valves. Ovary superior, 1-celled, 1-ovuled, with a single style. Fruit in ours a drupe.—A large family, chiefly tropical, including the Cinnamon, Camphor, Sassafras, Alligator Pear or Avocado, and the Bay Laurel of the ancients.

1. UMBELLULARIA Nutt.

Flowers in simple peduncled umbels. Sepals 6. Stamens 9, the inner three with a stipitate orange-colored gland on each side of the filament at base and alternating with scale-like staminodia; anthers 4-celled, 4-valved, the three inner extrorse, the outer introrse.—One species only. (Diminutive of Latin umbella in reference to the flower cluster.)

California Laurel.

1. UMBELLULARIA CALIFORNICA Nutt. Fig. 102.

Leaves aromatic, oblong, tapering rather more to apex than to base, thickish, entire, 3½ to 4½ inches long, ¾ to 1 inch wide, short-petioled; umbels 4 to 9-flowered, but setting only 1 to 3 (or rarely 6) fruits; flowers small (2 lines long), yellowish green; drupe greenish or when ripe reddish or brown-purple, 1 to 1¼ inches long; seed without endosperm, the embryo with two large thick seed-leaves and a short caulicle.

California Laurel, often called Bay Laurel and Pepperwood, assumes several distinct forms as modified by the character of the local habitat. In valley flats, cañon bottoms

or on moist hill slopes it is a tree 25 to 100 feet high with a dense and often massive crown of long slender upright branches, the trunk 1 to 4 feet in diameter with a thin drab or brown bark ¼ to ½ inch thick. This is the most usual form, a type common in the Santa Cruz Mountains, Berkeley

Fig. 102. CALIFORNIA LAUREL (*Umbellularia californica* Nutt.). Fruiting branchlet, nat. size.

Hills, about Mt. Tamalpais, in the valley flats about Olema and in the hill country through the North Coast Ranges generally. The finest groves of Laurel in California are found on the river bench of the main Eel River near Camp Grant where there is for several miles a pure stand of magnificent trees.

On the summit of the Berkeley Hills and in similar situations Laurel grows on rock outcropping and forms small many-stemmed clumps or bushy knobs which are a characteristic feature of such barren landscapes (Fig. 103). In the Coast Range chaparral it is sometimes seen as a low narrow-crowned dwarf 4 to 6 feet high, and on bluffs facing the sea its crown is developed in a contrary direction, spreading out over the ground as a low green mat of considerable diameter. Its most interesting modification occurs in wind-gaps in the hills of the San Francisco Bay region where it colonizes sharp north slopes in pure stands 5 to 20 feet high. These colonies are very dense, consisting of slender pole-like trees (usually stump-sprouts) with long trunks and surmounted by a usually narrow broom-like top. The whole surface of the colony from above presents a very smooth and even appearance, as if clipped with a lawn mower, a feature which is due to control by the high wind velocities which prevail in the wind-gaps. The most beautiful and interesting example of this type occurs at Inverness on the south slope of the "first valley." Examples may also be seen in the cañon of the west branch of San Pablo Creek on the east slope of the Berkeley Hills near Fish Ranch.

The largest known California Laurel grows near the town of Cloverdale on an alluvial bench of the Russian River. Its crown is about 90 feet broad and 75 feet high and its perfect trunk is 4 feet 10 inches in diameter at 5 feet above the ground.

Umbellularia californica is widely distributed in both the Coast Ranges and Sierra Nevada, ranging south into Southern California and north to the South Fork of the Umpqua River in southern Oregon. To many travelers in central California it is one of the most pleasing of our species on account of its dense dark crowns which form a foil to dry brown hills of which this tree is often the only arboreal tenant.

The wood is heavy, hard and strong and takes a high polish. It has been used for furniture (especially bed-room sets), stave timber and shoe lasts.

Fig. 103. CALIFORNIA LAUREL, clumps (like round knobs) on rock outcroppings in the Berkeley Hills.

ROSACEAE. ROSE FAMILY.

Herbs, shrubs or trees with alternate leaves and persistent stipules. Flowers perfect, perigynous or epigynous. Calyx 5-lobed. Petals 5, rarely none. Stamens generally 10 to numerous, inserted with the petals on the margin of the disk lining the calyx-tube. Pistils 1 to many, distinct and free from the calyx, 1-celled with one style and stigma, or united into a 2 to 5-celled ovary, which is partly or completely inferior; styles as many as the carpels. Fruit a follicle, an achene, a drupe, a cluster of drupelets (as in a blackberry), or a pome. Seeds with straight embryo; endosperm usually none.—A large and variable order furnishing many of the cultivated plants of garden and orchard, such as the spiraea, rose, blackberry, cherry, peach and pear; 90 genera widely distributed over the whole earth.

Leaves alternate, simple.
  Ovary superior.
    Fruit an achene; flowers small, without petals... 1. CERCOCARPUS.
    Fruit a drupe; flowers with petals.....2. PRUNUS.
  Ovary inferior; fruit a pome; flowers with petals.....3. PYRUS.
Leaves opposite, pinnately divided, remarkably fern-like; ovary superior .....4. LYONOTHAMNUS

1. CERCOCARPUS HBK.

Deciduous shrubs or low trees with spur-like branchlets and simple coriaceous straight-veined leaves. Flowers from winter buds, solitary or fascicled, terminal on the short branchlets. Calyx consisting of a slender pedicel-like tube

abruptly expanded into the low-hemispherical deciduous 5-toothed limb. Petals none. Stamens numerous, borne in two or three rows on the calyx. Pistil 1, with a 1-celled ovary, 1 ovule and a single long style and terminal stigma. Fruit a villous achene enclosed in the persistent calyx-tube and surmounted by the very much elongated twisted soft-hairy style. —Seven species, Pacific North America.

Flowers solitary or rarely in pairs; leaves narrowly lanceolate .....1. *C. ledifolius.*
Flowers in 2 to 5-flowered clusters.
Leaves ovate to elliptic; clusters 4 to 5-flowered.....2. *C. traskiae.*
Leaves obovate, cuneate at base; clusters 2 to 3-flowered.....
.....3. *C. parvifolius.*

Mountain Mahogany.

1. CERCOCARPUS LEDIFOLIUS Nutt.

Leaves narrowly lanceolate, acute at both ends, entire with revolute margins, coriaceous, pale or rusty pubescent below, becoming glabrous and lustrous above, somewhat resinous, ½ to 1 inch long with a prominent midrib; flowers solitary or rarely in pairs, sessile; calyx-limb deeply toothed; calyx-tube in fruit 4 or 5 lines long, the achene 3 lines long, and its tail 2 or 3 inches long.

Mountain Mahogany, also called Curl-leaf Mahogany, is a shrub or scraggy tree 6 to 20 or rarely 40 feet high. It grows on arid slopes in the mountains and is most characteristic of the mountain ranges of the Great Basin region from the eastern slopes of the Sierra Nevada eastward through Nevada and Utah and northward to western Montana. It also occurs on the northerly slopes of the San Bernardino Mountains, on Mt. Pinos, and on the Scott Mountains, in northern California.

The wood is very dense, fine-grained and heavy; it has a reddish mahogany color, whence the common name, but splits badly in seasoning.

Trask Mahogany.

2. CERCOCARPUS TRASKIAE Eastw.

Leaves broadly ovate to elliptic, dark green above, densely white woolly beneath, the parallel nerves fairly prominent, remotely crenulate above middle or seemingly entire by reason of the revolute margin, 1¼ to 2 inches long; flowers 4 or 5 in a cluster; achene 4 or 5 lines long, the tail 2 to 2¼ inches long.

The Trask Mahogany is a little-known tree 15 to 25 feet high growing on Santa Catalina Island where it was dis-

covered by Mrs. Blanche Trask in a steep cañon on the south side.

3. **Cercocarpus parvifolius** Nutt. HARD TACK. Shrub; leaves obovate, serrate above the middle, cuneate and entire towards base; clusters 2 to 3-flowered.—Common chaparral shrub throughout the Coast Ranges and Sierra Nevada. Often called Mountain Mahogany and also Hard Tack by the mountaineers, the dry wood so hard that "common nails cannot be driven into it."

2. PRUNUS L. PLUM.

Shrubs or small trees. Leaves simple, serrate. Flowers white, in corymbs or in racemes from lateral buds borne on wood of the previous season, appearing before or with the leaves. Petals 5. Calyx 5-cleft, deciduous after flowering. Stamens 15 to 30. Pistil 1; style terminal. Drupe globose, without bloom; flesh sweet or bitter; stone globose or compressed, bony.—Chiefly north temperate, about 75 species, including the cherries, apricots and peaches. (The Latin name of the Plum.)

Leaves conduplicate in bud; drupe globose.—CHERRIES.
- Flowers in corymbs; drupe small, bright-red.....1. *P. emarginata.*
- Flowers in racemes; drupe dark-red.
  - Peduncle leafy; drupe small, its flesh astringent; foliage deciduous.....2. *P. demissa.*
  - Peduncle leafless; drupe large, its flesh sweetish; foliage evergreen.....3. *P. ilicifolia.*

Leaves convolute in bud; drupe red, oblong, ¾ to 1 inch long.—PLUMS.
- Flowers in umbels.....4. *P. subcordata.*

1. **Prunus emarginata** Walp. BITTER CHERRY. Deciduous shrub 3 to 8 feet high, very rarely arboreous and 20 feet high; bark smooth, dull red; leaves ovate or more commonly oblong-obovate, mostly obtuse, finely serrulate, ¾ to 1½ inches long, on petioles 1 to 3 lines long; blade with 1 or 2 glands just above junction with petiole; flowers 3 to 10 in short corymbs; drupes 4 or 5 lines long, bright red, the pulp intensely bitter.—Sierra Nevada and Coast Ranges, abundant at 4,000 to 8,000 feet, also at lower levels near the ocean, as in cool cañons of the Berkeley Hills at 500 feet; ranging southward to the mountains of Southern California (5,000 to 9,000 feet), eastward to the San Francisco Mountains of Arizona and northward to southern British Columbia and Montana. Forms extensive shrubbery thickets on dry or moist gravelly mountain slopes, and attains its largest size near streams or on moist benches.

2. **Prunus demissa** Walp. WESTERN CHOKE-CHERRY. Erect slender deciduous shrub, 2 to 10 feet high, or rarely a small tree up to 20 feet in height; leaves oblong-ovate or more commonly oblong-obovate, acute at apex or abruptly short-pointed, finely serrate, 1 to 3½ inches long; petiole ½ inch long, with 1 or 2 glands just below its summit; racemes 2 to 4

inches long, terminating more or less leafy peduncles; drupe red or dark purple, 3½ lines long, astringent.—Sierra Nevada, 2,500 to 4,000 feet at the north and 3,500 to 6,000 feet at the south; Coast Ranges, widely scattered from near the sea to the interior; Southern California south to Palomar; far northward to British Columbia and east to the Rocky Mountains.

Islay.

3. PRUNUS ILICIFOLIA Walp.

Leaves coriaceous, elliptic or ovate, acute or obtuse, spinose-toothed, 1 to 2 inches long, short-petioled; racemes 1 to 2½ inches long, on axillary leafless peduncles; flowers 2 lines long; drupe red or dark purple, 6 to 8 lines thick, slightly obcompressed, apiculate; flesh thin, sweetish when ripe.

Islay is an evergreen shrub or small tree 5 to 25 feet high. It is most interesting for its holly-like leaves and remarkably large drupes with surprisingly little flesh. It is distributed through the Coast Ranges near the ocean from the San Francisco Peninsula and Oakland Hills south to the Sierra Madre and San Bernardino mountains. It also occurs in arborescent form in the Napa Range near Cordelia. Island Cherry (Var. INTEGRIFOLIA Sarg.) is a variety of the Santa Barbara Islands assuming tree form (10 to 45 feet high) or often bushy. Its leaves are oblong-ovate, usually entire, 3 to 6 inches long.

4. **Prunus subcordata** Benth. SIERRA PLUM. Deciduous shrub 5 to 7 feet high or sometimes arborescent and 20 feet high, with crooked and rough gray-brown branches and more or less spinescent branchlets; leaves ovate, elliptic to almost round, obtuse or truncate at base, rarely subcordate, 2 inches long or less, on petioles 2 or 3 lines long; flowers appearing with the leaves, 2 to 4 in a cluster, on pedicels ½ inch long; sepals linear or slightly acute, 1½ lines long; petals obovate, somewhat concave, 4 lines long; stamens 25 or 30; drupe red, ¾ to nearly 1 inch long, the pulp rather hard but more or less edible.—Northern Sierra Nevada to the Warner Mountains, Siskiyou County, into southern Oregon and south in the Coast Ranges to the Vaca Mountains, mostly toward the interior.

3. PYRUS L. PEAR. APPLE.

Deciduous trees or shrubs with simple leaves and stipules which disappear early. Flowers in corymbs. Calyx-tube urn-shaped. Petals white or pink, with claws. Ovary inferior, 2 to 5-celled, ovules 2 in each cell, the carpels chartaceous; styles as many as the cells, united at base. Fruit a pome, in the subgenus Malus (apple) more or less globose and sunken at each end.—Northern hemisphere, about 40 species. (The Latin name of the Pear.)

Oregon Crab Apple.

1. PYRUS RIVULARIS Dougl.

Leaves ovate, pointed, serrate, green above, pale, pubescent and eventually rusty beneath, 1 to 3¾ inches long, those of the sterile branchlets mostly 3-lobed or with a coarse tooth on each side, those of the flowering branchlets rarely lobed or toothed; corymbs 6 to 8-flowered; petals elliptical, 5 lines long, commonly with toothed auricles just above the very short claw; stamens about 20; carpels commonly 3; fruits 2 or 3 in a cluster, oblong or oblong-ovoid, 6 or 7 lines long and 4½ or 5 lines thick, not sunken at base, yellowish (or pinkish on one side), aging purple-black; calyx-lobes at length deciduous.

Oregon Crab Apple is a tree 15 to 30 feet high or often a many-stemmed shrub. It is uncommon in California but has been reported from the following stations: Napa Soda Springs; Sonoma County; Eureka; Plumas County. Northward it ranges into western Oregon and Washington, where it reaches its greatest development, extending as far north as southern Alaska.

4. LYONOTHAMNUS Gray.

Evergreen shrub or tree with thin bark exfoliating in long loose strips and opposite dimorphic petioled leaves. Flowers numerous in a much-branched terminal panicle. Petals 5 and stamens 13 to 16, inserted on the margin of the woolly disk lining the calyx-tube which bears 5 lobes. Pistils 2, distinct, each with a spreading style and capitate stigma. Fruit consisting of two woody 4-seeded carpels dehiscent ventrally and partly dehiscent dorsally.—One species. (Named in honor of W. S. Lyon, who sent specimens to Asa Gray in 1884, the surname in combination with Greek thamnos, shrub.)

Catalina Ironwood.

1. LYONOTHAMNUS FLORIBUNDUS Gray.

Leaves oleander-like, linear, nearly entire or pinnately cut, petioled, 3 to 5 inches long, or often pinnately compound with 2 to 5 leaflets similar in shape and size to the simple leaves; flowers white, 3 lines broad, in terminal clusters 3 to 6 inches broad; calyx-tube hemispherical, woolly outside, with nearly triangular lobes; petals orbicular, sessile, white, crenulate-edged.

Catalina Ironwood is a slender tree 15 to 55 feet high with narrow crown and often tall trunk 3 to 12 inches in diameter. It is a strictly insular species confined to four of the Santa Barbara Islands and is most remarkable for its leaf variability.

Trees with compound or fern-like leaves only grow on Santa Rosa, Santa Cruz and San Clemente islands, while the entire-leaved form is dominant on Santa Catalina. Pinnate leaves are, however, found on entire-leaved trees on Catalina, and probably the converse is true of some of the trees on the other islands.

LEGUMINOSAE. PEA FAMILY.

Herbs, shrubs, or trees. Leaves alternate, stipulate, compound or rarely simple. Flowers perfect, somewhat perigynous (frequently more on one side than the other), or hypogynous. Calyx synsepalous, usually 5-toothed or cleft, or sometimes bilabiate, mostly persistent. Corolla with 5 petals, regular or in ours commonly papilionaceous, i.e., highly irregular and butterfly-like, with an upper petal or "banner," 2 lateral petals or "wings," and the 2 lower petals joined by their edges to form the "keel," all with free claws. Stamens 10, united into a sheath around the ovary (monadelphous), or the upper stamen distinct from the others (diadelphous), or sometimes all distinct. Pistil 1, one-celled, with single style and stigma. Fruit a 2-valved pod (legume), with 1 or 2 rows of seeds on the ventral side, commonly opening by both the dorsal and ventral sutures, or sometimes indehiscent. Seeds without endosperm.—Vast family, about 7,000 species, widely distributed in both hemispheres and including the Pea, Caesalpinia, and Mimosa tribes.

Stamens distinct; corolla regular or imperfectly papilionaceous; leaves bipinnate; branches more or less spiny.
- Flowers small, regular; calyx campanulate; stamens much exserted .....1. PROSOPIS.
- Flowers medium-sized, the upper petal larger; calyx with stipe-like tube; stamens included.....2. CERCIDIUM.

Stamens monadelphous or diadelphous; corolla papilionaceous.
- Leaves simple, glandular-dotted; branchlets numerous, spinose..... .....3. DALEA.
- Leaves once pinnate, without glandular dots; spines in pairs below petioles .....4. OLNEYA.

1. PROSOPIS L.

Shrubs or trees, the branches armed with spines and without terminal buds. Leaves alternate on the season's shoot, fascicled in earlier axils, deciduous, bipinnate with 1 or 2 pairs *of pinnae,* the leaflets small, numerous, entire and in equal

pairs. Flowers regular, small, greenish, sessile, in axillary pedunculate cylindrical spikes. Calyx campanulate, with short teeth, deciduous. Petals 5, connate below the middle or at length free, tomentose on inner side, very much exceeding the calyx. Stamens 10, free, exserted, the anthers tipped with a deciduous gland. Ovary stipitate, villous; style filiform. Pod straight, curved or coiled, indehiscent, the many seeds separated by thick spongy partitions.—Tropic and subtropic regions, about 25 species.

Leaflets 10 to 15 pairs; spines axillary, in pairs, singly or none; pod straight or curving, compressed.....1. *P. juliflora.*
Leaflets 5 to 8 pairs; spines in pairs, stipular; pod spirally coiled into a straight cylindric body.....2. *P. pubescens.*

Mesquite.

1. PROSOPIS JULIFLORA DC.

Petioles abruptly enlarged and glandular at base, bearing usually 2 pinnae, with 10 to 15 pairs of linear leaflets ½ to 1 inch long; stipules linear and membranaceous; spines axillary, often in pairs or sometimes absent, ¼ to 1¼ inches long; flowers 2 lines long, condensed in slender cylindrical spikes mostly 2 to 3½ inches long; stamens twice as long as the petals; pods borne in drooping clusters, 1 to 6 to each spike, linear, at first flat, later becoming thickened, falcate, 4 to 8 inches long, commonly 4 or 5 lines broad, irregularly constricted between the seeds which are about 3 lines long.

Mesquite, called Algaroba by the Mexicans, is a deciduous shrub or small tree with a short trunk dividing into crooked branches commonly forming a rounded or depressed crown, 10 to 15 or rarely 35 feet high. It is a characteristic shrub of the Mohave and Colorado deserts, ranging northward to Death Valley and into the upper San Joaquin Valley in Kern County, eastward to Texas and southward in various forms to Chile.

It is a remarkable desert tree and is exceedingly useful in many ways to the desert tribes and white settlers. The pods furnish a staple food to the Indians as well as to their saddle ponies. The wood is used by Indians for building houses and for household implements. Wind-blown desert sands gradually bury the trees save the tops and such mounds are excavated for fuel—one of the great resources of miners and settlers in the desert region. The flowers furnish food to the honey bee, whence the common name, Honey Mesquite.

Screw Bean.

2. PROSOPIS PUBESCENS Benth.

Spines stout, stipular, 2 to 6 lines long; leaves canescently puberulent, the leaflets in 5 to 8 pairs, oblong, 1 to 5 lines long; flowers 2 lines long, borne in spikes 2 to 3 inches long, each spike setting 2 to 15 pods; pod coiled into a narrow straight cylindric body 1 to 1½ inches long; seeds less than 1 line long.

Screw Bean often called Screw-pod Mesquite, the Tornillo of the Mexicans, is a deciduous shrub or small tree 10 to 25 feet high with spiny branches and trunk 3 to 10 inches in diameter. It grows in sandy or gravelly washes or ravines and is distributed throughout the Colorado and Mohave deserts of Southern California, northward to Death Valley, eastward to southern Utah and New Mexico, and southward to northern Mexico. The beans are sweet and nutritious and are used as food by the Indians and fed as fodder to cattle.

2. CERCIDIUM Tulasne.

Shrubs or small trees, often armed with short spines. Leaves bipinnate with one or two pairs of pinnae and 2 to 4 equal pairs of leaflets. Flowers on jointed pedicels in short axillary racemes. Calyx shortly campanulate, the limb cleft into 5 reflexed deciduous lobes. Petals bright yellow, clawed, the upper one broader than the rest, a little auricled at base of blade, and with longer claw. Stamens 10, distinct, the filaments hairy at base, one or two next upper petal gibbous on one side toward base. Pod compressed, 2-valved, narrow, pointed at each end, more or less constricted between the flat seeds.—Six species, California to Chile. (Greek cercidion, a weaver's shuttle, in reference to the fruit.)

Palo Verde.

1. CERCIDIUM TORREYANUM Wats.

Spines 2 or 3 lines long; leaflets oblong, 2 to 4 lines long; pedicels 5 to 8 lines long, jointed near the middle, the joint not obvious until the fruit has matured; flowers ¾ inch broad, in axillary racemes; petals orbicular to ovate, yellow, 4 to 5 lines long; pods 2 to 3 inches long with a double groove along the ventral suture, often conspicuously contracted between the seeds.

Palo Verde is a small intricately branched tree 15 to 20 feet high with short trunk, smooth green bark and crown leafless for most of the year. It is "common in the sandy washes or depressions throughout the Colorado Desert of Southern Cali-

fornia, eastward into southern Arizona and southward into Lower California and Sonora. The leaves fall soon after they appear in March but the trees still present a cheerful appearance on account of the bright green bark (whence the Spanish name), which is all the more pleasing on account of the contrast with the parched desert scenery. The pods fall in July and are harvested by the native tribes of the region who prepare them for food. The branchlets are browsed by cattle, horses and deer, and the flowers are visited by the honey-bee."*

3. DALEA L.

Glandular punctate herbs, small shrubs or small trees. Leaves unequally pinnate or simple; stipules small, subulate; leaflets small, entire. Flowers in terminal spikes or racemes. Calyx with 5 nearly equal teeth or lobes, persistent. Banner cordate with free claw; claws of wings and keel adnate to the cleft stamineal tube. Stamens 10, rarely 9, monadelphous. Pod ovate, compressed, usually indehiscent, more or less included in the calyx, 1 to 2-seeded. Seeds reniform.—New World, about 100 species. (Dr. Samuel Dale, English botanist and author of a materia medica published in 1693.)

Smoke Tree.

1. DALEA SPINOSA Gray.

Branchlets numerous and reduced to slender spines 1 to 1½ inches long, coated with a close white pubescence, sparingly sprinkled with small glands and minute caducous bracts, ultimately glabrous; leaves few, simple, cuneate or linear-oblong, nearly sessile, ½ to 1 inch long, marked with a few large glands and persisting only a few weeks; flowers violet-purple, 4 to 5 lines long, borne in a spinescent spike, ½ to 1 inch long; calyx-tube turbinate, conspicuously 10-ribbed, with short obtuse teeth and marked by a row of conspicuous glands; petals attached only by their bases to the stamineal tube; banner furnished at base of blade with 2 conspicuous glandular processes; ovary densely pilose on the margins, with several dot-like glands on the sides and containing 6 ovules; pod twice longer than the calyx, 1-seeded.

Smoke-tree is a very spinose and nearly leafless ashy-gray low shrub or small tree 4 to 25 feet high with intricately much-branched top and trunk 2 to 10 inches in diameter. It is common in dry washes from Palm Springs and the Chuckawalla Bench eastward throughout the Colorado Desert to the Gila River in Arizona, and southward to San Felipe, Sonora and

*Jepson, Silva of California, Mem. Univ. Cal. No. 2.

Lower California. It has been so named on account of its appearance, being so truly deceptive as to cause the uninitiated to watch it with speculative wonder as to where "that column of smoke comes from."

4. OLNEYA. Gray.

Small tree with thin scaly bark, slightly angled branchlets, pinnate leaves with entire leaflets, and often armed with stout spines in pairs below the leaves. Flowers few, in axillary racemes. Calyx subcampanulate, 5-lobed. Banner orbicular,

Fig. 104. BUCKEYE (*Aesculus californica* Nutt.). Flowering branch, ⅓ nat. size.

deeply emarginate, reflexed; wings oblong; keel broad, obtuse, incurved. Stamens 10, diadelphous. Ovary with numerous ovules; style bearded above. Pod thick, broadly linear or ovate, with coriaceous valves, 1 to 2-seeded, tardily dehiscent. —One species. (Stephen T. Olney, Rhode Island botanist of the 19th century.)

Desert Ironwood.

1. OLNEYA TESOTA Gray.

Leaves persistent through the winter; leaflets 5 to 7 pairs, cuneate-oblong or -obovate, obtuse or notched at apex, 3 to 6 lines long; stipular spines stout, straight or slightly curved, 1 to 4 lines long; flowers violet-purple, 4 or 5 lines long, 3 to 10 in loose racemes ½ to 1¼ inches long; pods glandular, more or less pubescent and often provided with tack-shaped glands, ½ to 3 inches long, 1 to 8-seeded, more or less constricted between the seeds; seeds ovoid-globose, 4 to 6 lines long.

Desert Ironwood, or Arbol del Hierro of the Mexicans, is a spreading tree 15 to 20 feet high with short trunk ¼ to 1½ feet in diameter. It grows in the desert valleys of Southern California from San Felipe northward to Chuckawalla and Indio, eastward to Arizona, and southward into adjacent parts of Mexico. Its wood is remarkably hard and heavy and is used by desert Indians for arrow parts and tool-handles.

SAPINDACEAE. BUCKEYE FAMILY.

Trees or shrubs with opposite compound leaves, no stipules, and irregular flowers. Ovary superior, 3-celled with 2 ovules in each cell, commonly but one ovule maturing. Endosperm none.—Chiefly tropical, 120 genera.

Fig. 105. BUCKEYE. *a*, Perfect flower, long-styled; *b*, staminate flower with short-styled sterile ovary; *c*, fertile pistil, ovary sessile; *d*, sterile pistil, ovary stipitate. nat. size.

AESCULUS L. HORSE CHESTNUT.

Leaves palmately compound with serrate leaflets, deciduous in autumn. Flowers showy, ill-scented, on jointed pedicels in a terminal cylindrical thyrse; they are of two sorts, perfect (fertile) with long thick styles and sterile with short styles; fertile flowers few near top of thyrse. Calyx tubular, unequally cleft. Petals 4 or 5, slightly unequal, clawed. Stamens 5 to 7, becoming successively much exserted and often unequal. Fruit a large 3-valved capsule, loculicidally dehiscent. Seed-coat thick and polished, with a large round scar; seed-leaves very large and fleshy. — North temperate zone, 14 species. (Latin name of an Italian oak with edible acorns.)

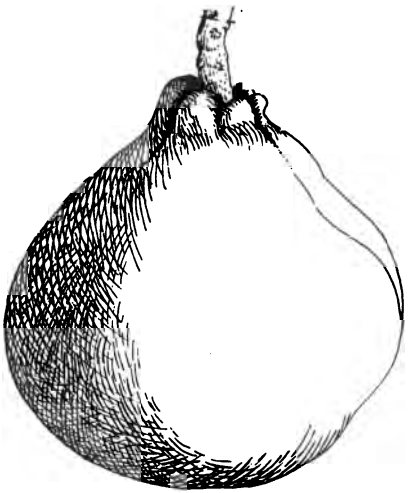

Fig. 106. BUCKEYE pod. nat. size.

California Buckeye.

1. AESCULUS CALIFORNICA Nutt. Figs. 104, 105, 106, 107, 108, and 109.

Leaves palmately compound with 5 to 7 leaflets; leaflets oblong-lanceolate to oblong-elliptic, acute or acuminate, petiolate, serrulate, 3 to 5 inches long; flowers 4 to 5 lines long, white or sometimes pinkish, borne in a cylindrical cluster 4 to 6 inches long, the 1 to 6 fertile ones in the upper part of the cluster; blade of petals elliptic or ovate, rotately spreading; after fertilization the sterile flowers fall away and the fertile flowers of the thryse set 1, or sometimes 2 to 9, pods which are pendulous on the now naked axis of the inflorescence; pods 1½ to 2½ inches in diameter, eventually releasing one large polished brown seed about 2 inches in diameter and with very tough coat.

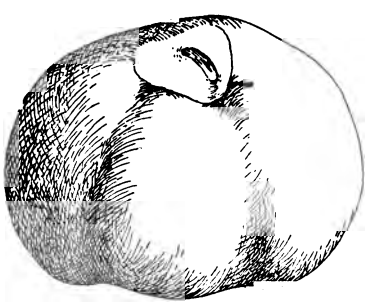

Fig. 107. BUCKEYE seed. nat. size.

California Buckeye is a tree 10 to 30 feet high with a low broad rounded crown and trunk ⅓ to 3 feet in diameter. The bark is smooth and white, or on old trunks fissured into thinnish scaly plates. It inhabits valley flats, river bottoms or more particularly lower hill slopes. On steep slopes, at the heads of cañons, or at the edge of chaparral it often forms open thickets of many-stemmed shrubs 5 to 8 feet high.

Aesculus californica is widely distributed in the Coast Ranges and Sierra Nevada foothills, north to South Fork Trinity and Redding, and southward to Fort Tejon and Antelope Valley. More characteristic of the interior hills, the Buckeye in a few places ranges to the immediate coast although shunning the main Redwood Belt. The trees are usually scattered along gulches or water-courses in the hills or form open groves on the lower slopes of the foothills just above the valley level, sometimes occurring in large size on river benches or moist flats.

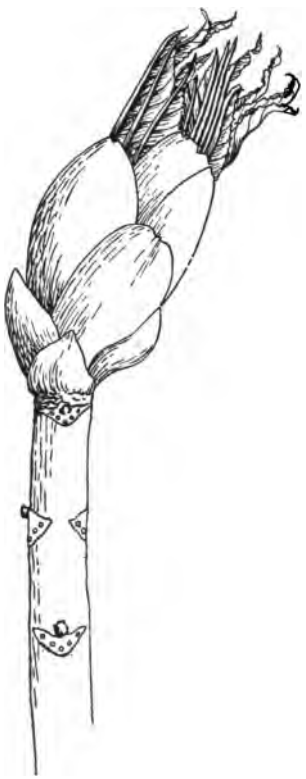

Fig. 108. Bursting winter bud of BUCKEYE, the leaf scars of last summer's leaves showing below. nat. size.

The California Buckeye, a tree of northern origin, with large winter buds and ample leaf surface, is rather interesting in its adaptation to arid dry-season habitats in California. The abundant foliage, of a rich dark green in spring, rounds the crown into most pleasing outline, a crown which in May or June is adorned with showy clusters of flowers. By early July the foliage is brown and heat-crumpled, and the leaflets are falling. (Fig. 109.) By September or October the naked limbs are bending under the burden of pods (Fig. 106) and by midwinter the tree stands white

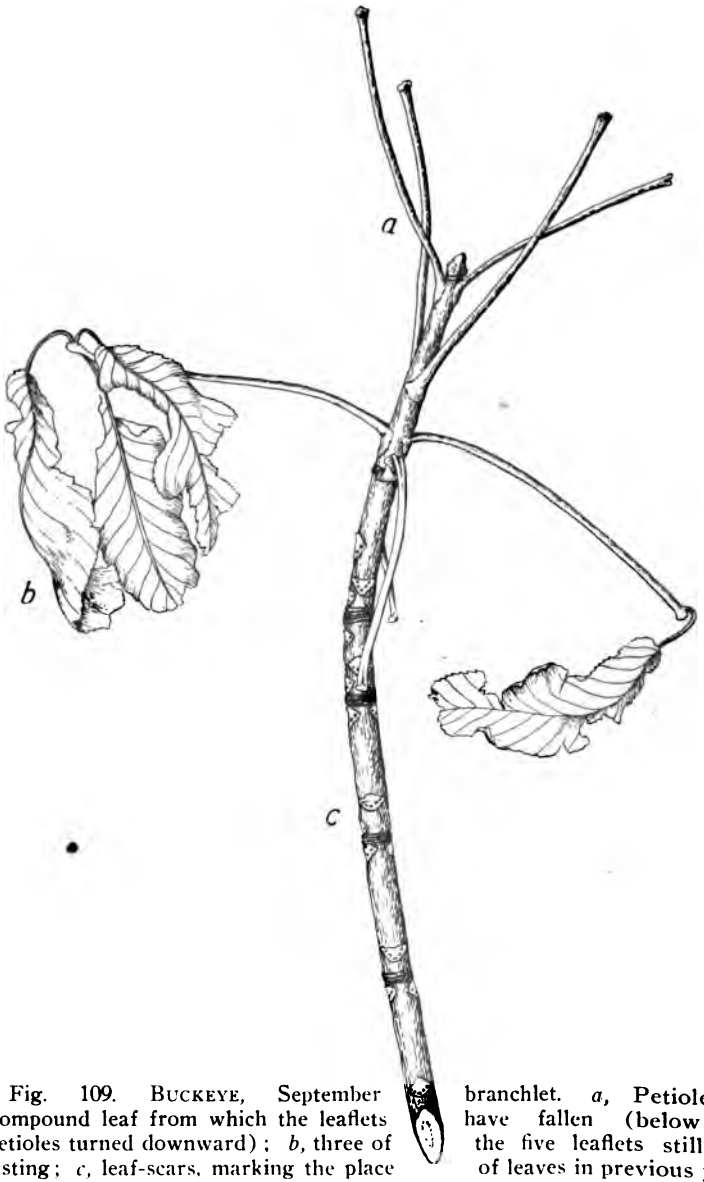

Fig. 109. BUCKEYE, September branchlet. *a*, Petioles of compound leaf from which the leaflets have fallen (below are petioles turned downward); *b*, three of the five leaflets still persisting; *c*, leaf-scars, marking the place of leaves in previous years, also dark circular scars indicating the position of the terminal winter bud at the end of each season's growth. ½ nat. size.

and naked against the bare brown rain-soaked earth of the foothills. Such marked changes in the physiognomy of a tree from season to season, while common in the woods of the eastern United States, are uncommon with us.

ACERACEAE. MAPLE FAMILY.

Deciduous trees or shrubs. Leaves opposite, petioled, simple or rarely compound, without stipules. Flowers regular, polygamous or dioecious, borne in axillary or terminal racemes, corymbs or fascicles. Calyx generally cleft into 5 segments, the petals as many or none. Stamens 3 to 10, borne on the edge of a disk or hypogynous. Pistil 1 with a 2-lobed 2-celled ovary and 2 styles. Ovary developing a long wing from the summit of each lobe and thus ripening into a double samara; samaras separable at maturity, the wings serving to rotate them rapidly in the air and further their horizontal flight when carried away by the wind.—Two genera, northern hemisphere.

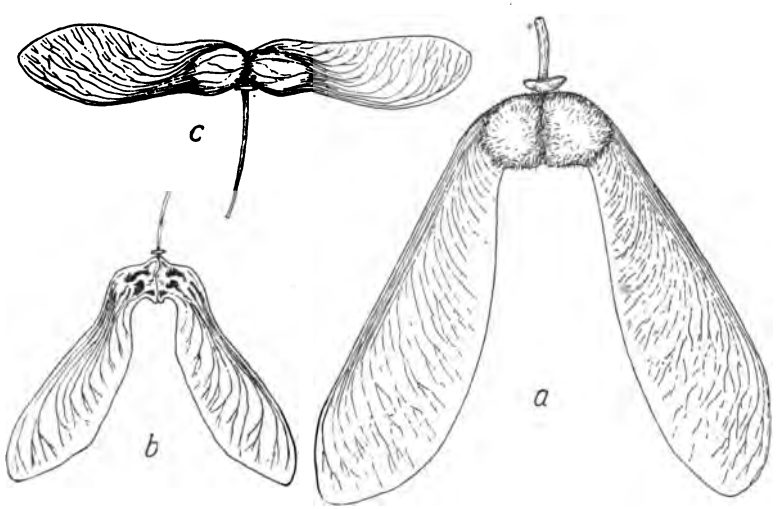

Fig. 110. Maple samaras. *a*, BIG-LEAF MAPLE (*Acer macrophyllum* Pursh). *b*, Sierra Maple (*Acer glabrum* Torr.). *c*, VINE MAPLE (*Acer circinatum* Pursh). nat. size.

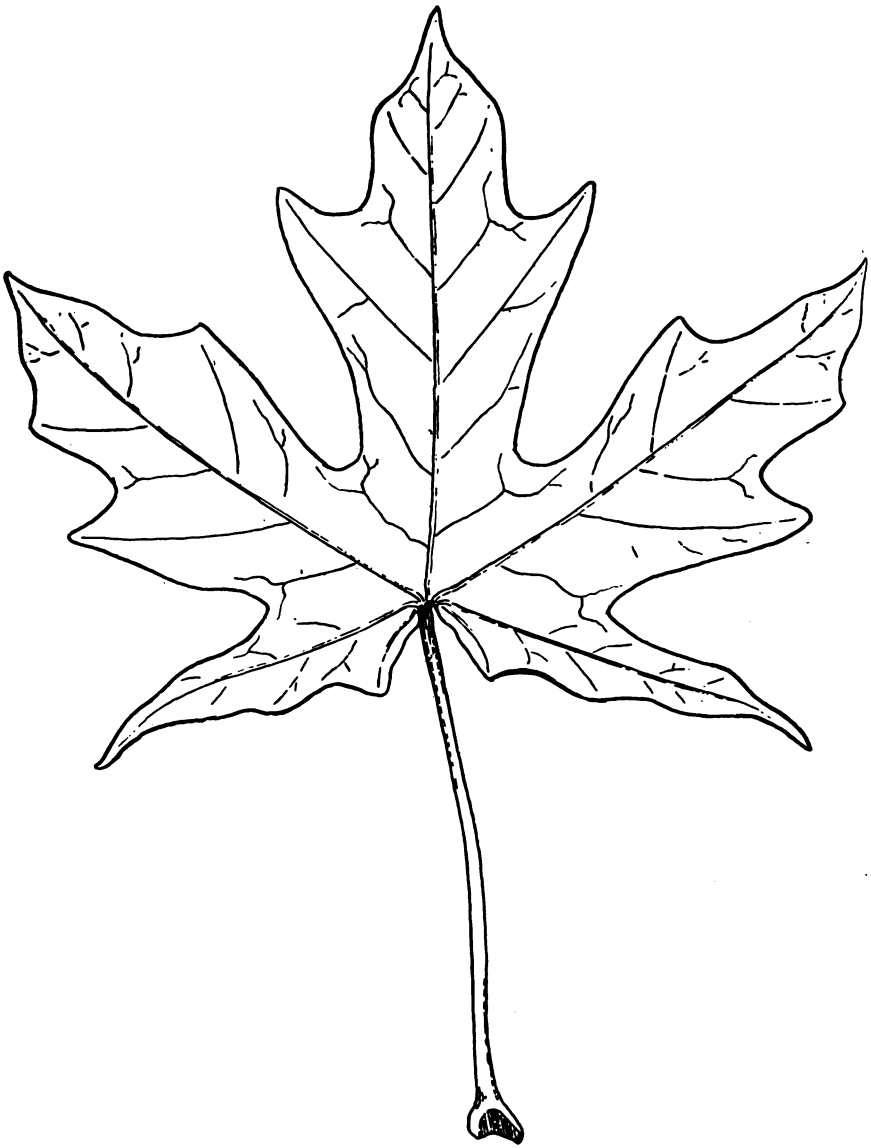

Fig. 111. BIG-LEAF MAPLE (*Acer macrophyllum* Pursh). Leaf, ½ nat. size.

ACER L. MAPLE.

Leaves simple and palmately lobed, or pinnately compound. Flowers small, in various kinds of clusters but the clusters always drooping.—About 100 species in north temperate zone, or ranging little beyond it. (Latin name of the maple tree.)

Leaves simple; petals present.
- Flowers in racemes; samaras more or less hispid; leaves large, deeply 5-lobed; lower altitudes chiefly.....1. *A. macrophyllum.*
- Flowers in corymbs; samaras glabrous.
  - Leaves shallowly but acutely 7 to 9-lobed; north coast.....2. *A. circinatum.*
  - Leaves mostly 3-lobed or parted; high-montane....3. *A. glabrum.*

Leaves pinnately or ternately compound; flowers dioecious; petals none; stream banks at lower altitudes.....4. *A. negundo.*

Big-Leaf Maple.

1. ACER MACROPHYLLUM Pursh. Figs. 110a and 111.

Leaves roundish in outline, palmately parted into 5 broad fingers which are mostly 2 or 3-lobed or -toothed, 4 to 8 or 10 inches broad; flowers yellowish white, borne in drooping racemes 2 to 4 inches long, perfect and staminate mixed in the same raceme, the lower half of the raceme sometimes wholly staminate; sepals elliptic, 2½ lines long, equalled by the oblong petals; stamens 7 to 9, those of the staminate flower exserted; body of the samara densely covered with short stiff hairs, the wings 1 to 1½ inches long and 6 to 8 lines wide.

Big-leaf Maple, often called California Maple or Oregon Maple, is a handsome broad-crowned tree 30 to 65 or even 95 feet high with a trunk 1 to 4 feet in diameter. The brownish gray bark is broken into narrow interwoven ribbon-like ridges, or sometimes checked into small squarish plates. It inhabits the banks or bottoms of constant streams, moist valley flats or springy mountain sides (wherefore the folk-name, Water Maple), and is distributed through the Coast Ranges (200 to 3,000 feet) and Sierra Nevada (2,000 to 5,000 feet) southward to San Diego County and north to southern Alaska. In California it is forestrally a rather rare or at least very subordinate tree in our woodlands and over large areas it is merely an occasional tree in the most favored situations, the banks or benches of streams.

As an ornamental tree Big-Leaf Maple has been widely planted. It is also highly valued as a street and roadside tree, being the most available native tree for this purpose, on account of its extremely rapid growth, its adaptability to street

conditions, and its fine crown and beautiful foliage. It is unfortunately our most difficult deciduous tree to transplant from the nursery.

The wood is reddish brown with white sapwood. It is rather hard and close-grained, takes a high polish and works easily. It has been used for tool-handles, furniture and interior finish. Mountaineers choose second-growth saplings for single-trees. The Indians of Oregon and Washington used the wood for boat paddles, gambling disks and sticks. With Redwood Creek Indians of Humboldt County, the twigs were used as "medicine" to bring riches, a fine compliment to those admirable qualities of the tree which are likewise sensed by the white man.

2. **Acer circinatum** Pursh. VINE MAPLE. (Figs. 110c and 112.) Shrub or sometimes a small tree, erect and 5 to 20 feet high, but more often vine-like or reclining; trunk 3 to 6 inches or rarely 1 foot in diameter

Fig. 112. VINE MAPLE (*Acer circinatum* Pursh). Leaf. nat. size.

with a smooth thin brownish red bark; leaves 2 to 4 inches broad, 5 to 7-lobed to the middle, with toothed margin, the lower pair of lobes smaller; flowers 4 to 10 or more in a corymb, most of them staminate, the cluster often setting but one fruit; sepals reddish brown, oblong, acute, nearly twice as long as the petals; petals white or greenish, 1 line long; stamens 6 to 10, shorter than the petals in the perfect flower but longer than the petals in the staminate flower; samaras glabrous, the wings spreading at right angles to the stalk; wings 7 to 10 lines long, 4 to 5 lines wide, scarlet when full grown; as the fruit ripens, the peduncle turns upward and finally the samara stands erect above the leaf.—Banks of streams and the depths of forests from the cañon of the upper Sacramento River to Mendocino and Humboldt counties and northward to southeastern Alaska. An attractive feature of the bottom lands and great forests of Oregon and Washington, where it sometimes attains a height of 35 feet. Most commonly the trunk branches at the very base into four or five spreading stems which curve over and, touching the ground, take root. Further offsets arise and result in extensive and well-nigh impenetrable thickets.

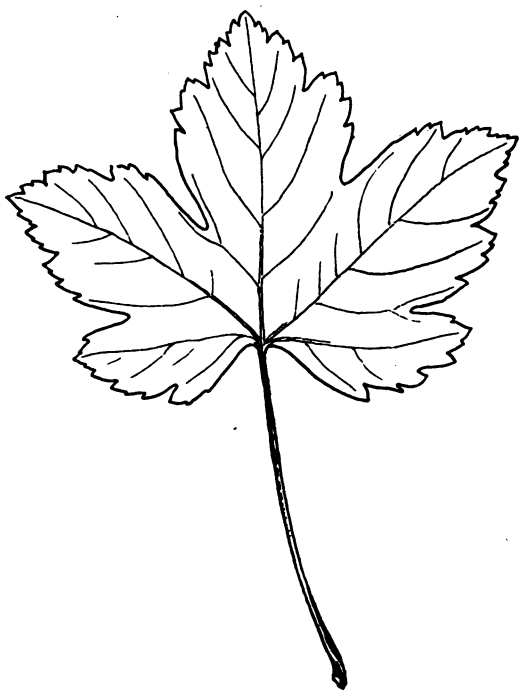

Fig. 113. SIERRA MAPLE (*Acer glabrum* Torr.). Leaf. nat. size.

The wood is heavy, hard and close-grained, and takes a high polish; in Oregon and Washington it is used for fuel, tool-handles, cabinet-work, boat-knees and barrel-hoops and for bowls and fish-net hoops by the native tribes of the Columbia River.

3. **Acer glabrum** Torr. SIERRA MAPLE. (Figs. 110b and 113.) Shrub 5 to 10 feet high with slender branchlets, the trunk 2 or 3 inches in diameter; leaves 1 to 3 inches broad, palmately 3-lobed or often with 2 supplementary lobes at base, the margin unequally serrate; flowers 4 to 9, in loose umbel-like corymbs, the staminate without rudiments of pistils and the pistillate with short stamens; corymbs unisexual or with both pistillate and staminate flowers, the sexes often borne on different shrubs; petals of the same length as the oblong sepals but narrower; stamens 7 to 10, the glab-

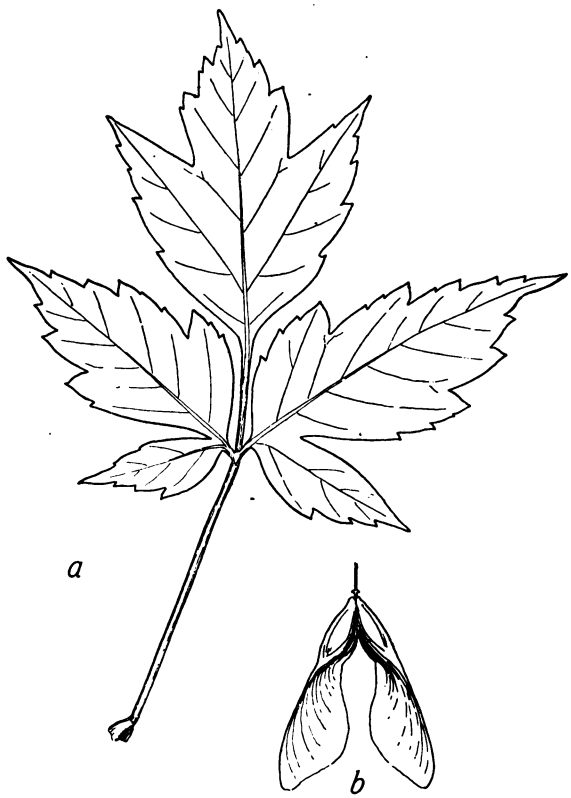

Fig. 114. BOX ELDER (*Acer negundo* var. *californicum* Sarg.). *a*, Leaf, ½ nat. size; *b*, samara, nat. size.

rous filaments arising from pits in the perigynous cushion; samaras usually several in a cluster, glabrous, with diverging wings 6 to 12 lines long and 4 or 5 lines wide.—Occasional in the Sierra Nevada on rocky cañon sides at 6,000 to 8,000 feet; high North Coast Ranges (Marble Mt., Siskiyous), forming thickets on wet mountain sides, the stems 10 to 150 in one bush-like clump; north beyond our borders to southeastern Alaska and east to the Rocky Mountains.

Box-Elder.

4. ACER NEGUNDO L. var. CALIFORNICUM Sarg. Fig. 114.

Leaves pinnately 3-foliolate, the leaflets commonly 1¼ to 5 inches long, serrate and incised, or deeply 2 or 3-lobed, or the lobes sometimes becoming distinct and petioled so that one or more of the primary leaflets is replaced by 2 or 3; staminate and pistillate flowers borne on different trees, without corolla and with minute calyx; staminate flowers clustered on thread-like hairy pedicels, the stamens 4 or 5; pistillate flowers borne in slender racemes; samaras straw-white, crimson when young, finely pubescent, the wings 6 to 8 lines long, 4 lines wide.

Box-Elder is a broad-crowned tree 30 to 45 feet high with trunk 1 to 1½ feet in diameter. It inhabits banks or bottoms of constant streams and is distributed through the Coast Ranges, Sacramento and San Joaquin valleys and Sierra Nevada foothills, ranging south to the San Bernardino and San Jacinto mountains. The trees in a locality are usually few and scattered and there are wide gaps in its distribution. It is rather more common along the Pajaro River between Pajaro and Sargent than seen elsewhere by the writer. On account of its hardiness and attractive foliage it is frequently used as a street tree in the cities and towns of California.

CACTACEAE. CACTUS FAMILY.

Trees or shrubs with fleshy or woody stems more or less studded with clusters of thorns (modified leaves), and without normal foliage. Flowers complete. Sepals and petals many, passing one into the other. Stamens numerous, inserted on the base of the corolla. Pistil compound; ovary inferior, 1-celled, with many parietal placentae; style one with many branches. Fruit fleshy, berry-like; seeds without endosperm.—Remarkable family, characteristic of deserts and arid areas; about 20 genera.

CEREUS Haw.

Habit diverse. Cushions geminate, borne on the vertical ribs, the lower spine-bearing, the upper producing a branch or flower. Calyx elongated. Stamens adnate at base to tube

of calyx. Seeds black.—About 100 species, chiefly in Mexico and South America. (Latin cereus, a wax-taper, on account of the columnar stem.)

Suwarro.

1. CEREUS GIGANTEUS Engelm. *Carnegeia gigantea* Britt. & Rose.

Foliage leaves none; flowers 4 to 4½ inches long; fruit oval, dehiscent by irregular valves.

The Suwarro, Giant Cactus or Monument Cactus, is a columnar tree, strongly 8 to 12-ribbed toward the base and with more numerous ribs above, 15 to 60 feet high, simple or with one or more (commonly 2 or 3) upright branches above the middle. It is one of the most remarkable trees of America. It grows in southern Arizona, crosses the Mexican line into the State of Sonora and has only recently been discovered on the California side of the Colorado River between the Needles and Yuma, where there are hundreds of trees. Its singular columnar growth and candelabra-like branches make it an extraordinary feature in the desert landscapes of the regions it inhabits.

CORNACEAE. DOGWOOD FAMILY.

Ours deciduous trees or shrubs. Leaves opposite, simple, entire. Flowers in cymes or heads. Calyx-tube coherent with the ovary, its limb represented by 4 small teeth at the summit or none. Petals 4, distinct, epigynous, valvate in bud. Stamens 4, alternate with the petals. Ovary 2-celled with a single pendulous ovule in each cell; style 1, filiform. Fourteen genera, widely distributed in both hemispheres.

1. CORNUS L. CORNEL. DOGWOOD.

Flowers regular and perfect, greenish or white, disposed in cymes or heads. Fruit a drupe, the stone 2-celled with 1 seed in each cell.—About 30 species, chiefly north temperate; 6 species in California, all shrubs except one. (Latin cornu, horn, on account of the hardness of the wood.)

Mountain Dogwood.

1. CORNUS NUTTALLII Aud.

Leaves roundish to narrowly obovate, with rounded or shortly acute apex, 3 to 5 inches long, on petioles 2 to 3 lines long; flowers crowded in dense heads, the heads on peduncles 1 to 1¼ inches long and surrounded by an involucre of white bracts; bracts commonly 6,

roundish to obovate or oblong with a short abrupt point at apex, 1½ to 3 inches long; flowers dull white, 3 lines long; petals broadly oblanceolate; fruit a scarlet drupe 5 or 6 lines long.

Mountain Dogwood is a shrub 6 to 10 feet high, or a slender tree up to 50 feet high with irregular crown and smooth whitish bark. It inhabits cool depths of mountain forests where the shade is deep and the soil moist. The individuals are usually scattered or rarely in small clusters. In the Sierra Nevada it occurs between 2,500 and 5,000 feet; in the Coast Ranges it is limited to the seaward ranges and to the middle North Coast Range. It extends south to the San Jacinto Mountains and north to southern British Columbia.

ERICACEAE. HEATH FAMILY.

Trees, shrubs or perennial herbs. Leaves simple, commonly alternate. Flowers regular, the parts usually in 5s. Stamens free or almost free from the corolla, as many or twice as many as its lobes; anthers 2-celled, opening by a terminal pore. Ovary superior or inferior, commonly 4 to 10-celled, with axile placentae and numerous ovules. Fruit a capsule or indehiscent and either dry or fleshy.—About 67 genera and 1,350 species, widely distributed in all zones.

1. ARBUTUS L. ARBUTE TREE.

Evergreen trees or shrubs with glossy leathery leaves. Flowers in a terminal panicle of dense racemes. Calyx small, 5-parted, free from the ovary. Corolla globular or ovate, 5-lobed at apex. Stamens twice as many as the corolla-lobes, included; filaments soft-hairy; anthers with a pair of reflexed awns on the back, each cell opening at the apex anteriorly by a pore. Ovary on a hypogynous disk, 5 or rarely 4-celled, the ovules crowded on a fleshy placenta which projects from the inner angle of each cell. Fruit a many-seeded berry with granular surface.—Over 20 species, northern hemisphere. (Latin name of the Arbute tree under which, says Horace, idle men delight to lie.)

Madroña.

1. ARBUTUS MENZIESII Pursh. Figs. 115 and 26.

Leaves narrowly elliptic or ovatish, 3 to 6 inches long, about 2 to 3 inches wide, rounded at apex or bluntly pointed, glabrous, dark green and polished above, glaucous beneath, the margin entire or, on stump sprouts

or vigorous shoots, finely serrate; petioles ½ to 1 inch long; flowers white, numerous in an ample terminal cluster; corolla ovate-globular, 3 lines long, with 5 very small lobes recurving from the small opening, and 10 semi-transparent glands in a circle at base with a slight constriction above them which becomes obvious on drying; fruit somewhat depressed globose, 4 to 5 lines in diameter, fleshy but rather dry, red, or orange-color when not fully ripe; seeds somewhat angular, closely crowded, 5 or 6 in a cell.

Madroña is a tree 20 to 125 feet high with trunk ½ to 5 feet in diameter, sometimes with a massive rounded crown, sometimes with a one-sided or irregular or very thin crown. The bark is terra-cotta color with a polished smoothness or on old trunks dark brown and fissured into small deciduous scales.

Arbutus menziesii ranges from Southern California to British Columbia. It occurs in the Sierra Nevada from the Lassen Peak foothills to the South Fork Tuolumne River, but is not common. It is most common in the North Coast Ranges where it grows on mountain ridges, slopes and gravelly valleys, reaching its greatest development in Mendocino and Humboldt counties where as an associate of Tan Oak, Douglas Fir and Black Oak it is everywhere a striking feature of the woods in the "Bald Hills" region inside the Redwood Belt.

Madroña is rarely symmetrical and the older the tree, the more unsymmetrical as a rule. This is notably the case in the Mendocino and Humboldt woods, where it is invariably pushed to one side when in light competition with Douglas Fir or Tan Oak. Huge Madroña crowns, wholly one-sided, are frequently met with; sometimes the aggressive companion trees disappear and leave these irregular Madroñas standing alone. Very frequently one finds a long trunk curving out of the perpendicular 20 or 30 feet and up 60 or 70 feet to a wisp of a crown occupying a very small area of the forest canopy. Such trees are remarkable for their curving and often huge trunks, which are commonly very tall and often flattened contrary to the direction of curve.

The contrast of color in bark and foliage is the most striking feature of the tree to the traveler. On branches or young trunks the bark is deep red and very smooth. When the summer growth begins it is deciduous in thin layers, *revealing* a satiny ground of pale green which ages into the

characteristic red or terra-cotta. The bark parts very readily from the wood, and girdled trunks, girdled without apparent provocation or as mere pastime, are often seen in the forest. Their color and smoothness, so attractive and distinctive to the forest lover, seem but as a challenge to the destructive instincts of the gross. Fortunately the trunk has the peculiarity of retaining a thin inner layer of the bark which the vandal

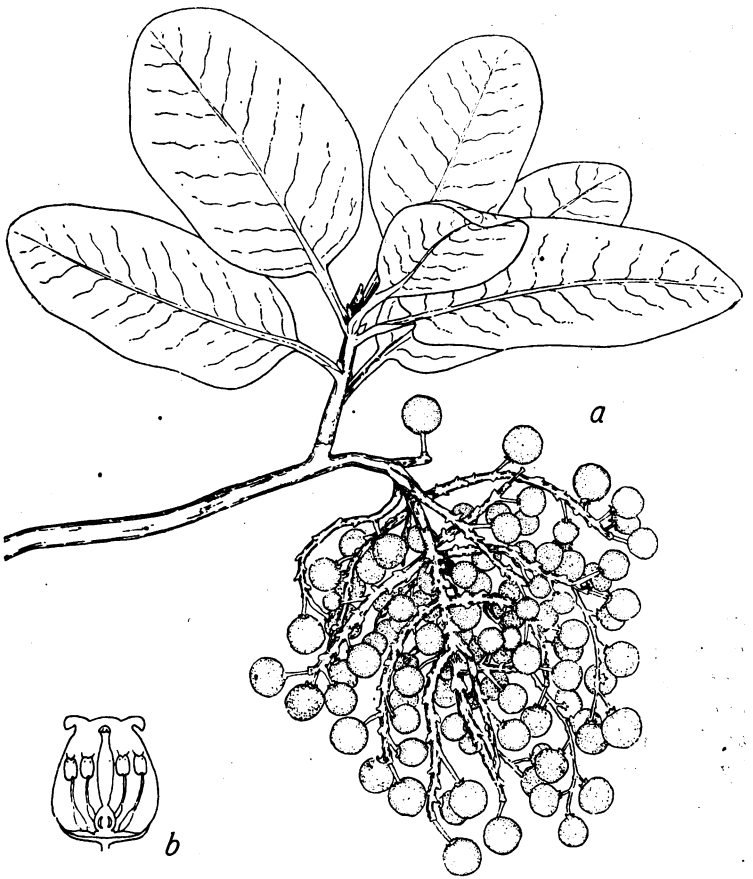

Fig. 115. MADROÑA (*Arbutus menziesii* Pursh). *a*, Fruiting branchlet with berries, ½ nat. size; *b*, longitudinal section of flower, 2½ times nat. size.

often ignorantly overlooks and the tree may live and flourish in spite of mutilation.

In its native woods Madroña has been little regarded by Californians, except by a chosen few who know the northern ranges. To these, what wonder that this tree inspires both pen and brush! It has been well depicted on the canvases of Welch and other artists and has, in addition, a permanent place in our California literature. When a boy Francis Bret Harte journeyed overland from Eureka to the Bay of San Francisco and in early youth gave to Californian poesy his happy lyric on this sylvan masquerader with velvet mantle and scarlet hose. So it is that the Madroña, the most handsome tree of Alta California — which enlivens the forests and the groves with its unrivalled woodland colors — will ever be associated with the man who has best portrayed the atmosphere of the Californian valleys and the foothills with their yellow cloaks.

No other of our trees, to those who know it in its regions of finest development, makes so strong an appeal to man's imagination — to his love of color, of joyful bearing, of sense of magic, of surprise and change. He walks the woods in June or July and rustles the mass of gold-brown leaves fresh fallen under foot, or rides for hundreds of miles across the Mendocino ranges — and always with a sense of fresh interest and stimulation at the varying presence of this tree.

For although of slight economic importance as a timber species it is in every other way a notable tree. Its crown of flowers and masses of crimson berries, its burnished foliage and terra-cotta bark, its manner of branching and habits of growth are alike full of interest and of charm. Wherever it grows the traveler, the forester, the hunter, the artist or the botanist is held by its spell and none such worthy of the name ever came out of the northern woods but returned to them again and again in waking or in dreaming moments, guided by the ordered paths of the intellect or loitering free in the crimson uplands of the imagination.

OLEACEAE. Ash Family.

Trees or shrubs mostly with opposite leaves. Flowers small, commonly in panicles, mostly unisexual. Stamens few (1 to 4). Ovary superior, 2-celled; style one. Fruit a samara,

capsule or drupe.—An interesting family distributed in all continents; 21 genera; Forsythia, Lilac, Olive, and Privet are cultivated with us.

1. FRAXINUS L. Ash.

Deciduous trees or shrubs. Leaves pinnately compound (except one species); terminal leaflet on a longer stalk than the lateral, or the lateral leaflets sessile. Flowers in small panicles, appearing just before the leaves and from separate buds. Corolla with 2 equal petals or none. Stamens 2 (rarely 1 or 3). Ovules 2 in each cell. Fruit a 1-seeded samara, with terminal wing.—Northern hemisphere, about 40 species. (The Latin name of the ash.)

Trees; corolla none; style conspicuously 2-lobed.
- Flowers dioecious; leaves pinnate; leaflets 2 inches long or more; branchlets terete.
  - Leaflets oblong to oval, the lateral commonly sessile; cismontane.....1. *F. oregona.*
  - Leaflets round-ovate, the lateral leaflets on petioles ¼ to ½ inch long; desert ranges.....2. *F. coriacea.*
  - Leaflets lanceolate, the lateral with petioles 1 line long; desert area .....3. *F. velutina.*
- Flowers polygamous; leaves simple, rarely with 2 or 3 leaflets; branchlets of the season 4-sided; desert area.....4. *F. anomala.*

Shrubs; corolla present; flowers perfect; style obscurely lobed; leaflets mostly stalked, less than 2 inches long; branchlets of the season strongly 4-sided; cismontane.....5. *F. dipetala.*

Oregon Ash.

1. FRAXINUS OREGONA Nutt. Fig. 116.

Leaves 6 to 12 inches long; leaflets 5 to 7, oblong to oval, or often broadest toward the apex and abruptly short-pointed, usually sessile except the terminal one, entire or toothed above the middle, 2 to 5½ inches long; flowers in small crowded clusters, destitute of petals; calyx of staminate flower very small, truncate, with 2 (sometimes 1 or 3) stamens; calyx of pistillate flower toothed, shorter than the ovary and persistent; samara oblong-lanceolate, 1¼ to 2 inches long, including the wing, the body clavate and ½ to ¾ inch long.

Oregon Ash is a tree 30 to 80 feet high with a rather broad round-topped crown and trunk ½ to 3 feet in diameter. The trunk bark is gray-brown, ⅛ to ¾ inch thick, fissured into narrow freely interlaced ridges.

Fraxinus oregona inhabits stream banks in ravines, river bottoms, and moist flats in valleys. It is widely distributed through the Sierra Nevada and Coast Ranges and is occasional

on the higher ranges of Southern California south to San Diego County. Beyond our borders it extends northward through western Oregon (where it is most abundant) and Washington to British Columbia. It grows along the Sacramento and San Joaquin rivers, ranging into the Sierra Nevada foothills to altitudes of 1,000 to 2,000 feet. In the South Coast Ranges it occurs sparingly, the writer having seen it only in the following localities: Walnut Creek; Carnadero Creek, Gilroy Valley; Santa Cruz Range. It is more common and widely distributed in the North Coast Ranges, occurring from Mt. Tamalpais to Napa Valley, east to the east slope of the Vaca Mountains and northward to Lake, Mendocino and Humboldt

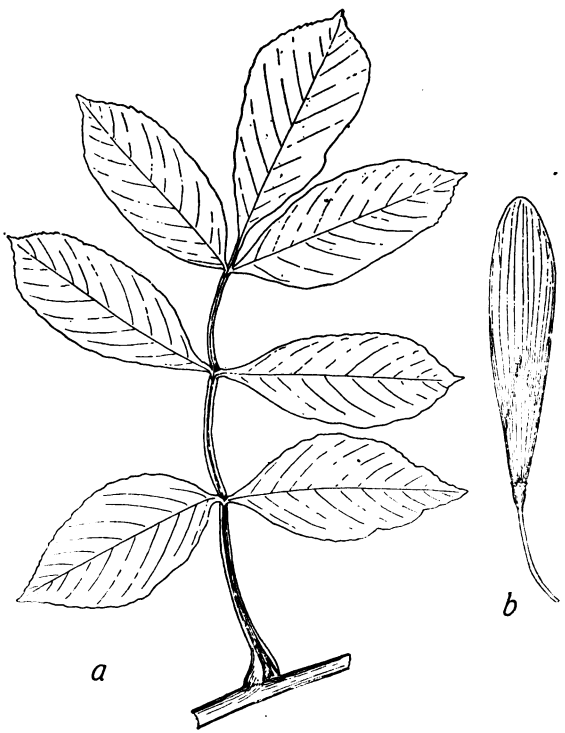

Fig. 116. OREGON ASH (*Fraxinus oregona* Nutt.). *a*, Compound leaf, ½ nat. size; *b*, samara, nat. size.

counties, where it is sometimes the dominant tree in the delta swamps of mountain valleys.

Its wood is rather coarse-grained, hard and strong and is used for interior finish, furniture, wagon parts, and implement handles. The supply in California is too small to be of importance other than for local uses.

Leather-leaf Ash.

2. FRAXINUS CORIACEA Wats.

Leaves compound, pale green, glabrous and 3 to 6 inches long; leaflets 5 to 7, round-ovate to elliptic or oblong, mostly abruptly pointed, 1½ to 3 inches long; petiole of lateral leaflets ¼ to ½ inch long, of terminal leaflets 1 inch long; margin entire or with minute scattered teeth; samaras 1 inch long with wings 1½ to 2 lines wide.

Leather-leaf Ash is a tree 20 to 30 feet high with round-topped crown and rough, gray trunk bark. It inhabits the desert regions from southern Utah to southeastern California; in the latter region it occurs on the east side of Owens Lake and at the east base of Mt. San Jacinto (2,000 feet altitude).

Arizona Ash.

3. FRAXINUS VELUTINA Torr.

Leaves compound; leaflets 5, lanceolate, 2½ to 4 inches long, ½ to ⅞ inch wide, green above, yellowish green beneath, mostly entire; petioles of lateral leaflets 1 line long, of terminal leaflet ½ inch long; samaras 1 inch long, the wing 2 lines wide.

Arizona Ash is a tree 15 to 30 feet high with grayish somewhat fissured bark and willow-like leaflets. It inhabits the banks of streams in cañons or the borders of lakes or springs. It is distributed from western Texas to southern Nevada, ranging west to the Panamint Mountains and Owens Lake in southeastern California, recurring at the southwestern base of Mt. San Jacinto at 2,200 feet.

Dwarf Ash.

4. FRAXINUS ANOMALA Wats.

Leaves simple, roundish or broadly ovate, partially serrulate or entire, ½ to 1½ inches long, or compound with 2 or 3 similar leaflets; flowers either perfect or pistillate, both forms occurring in the same cluster; samara 8 to 9 lines long with a rounded wing which surrounds the body and is 4 to 5 lines wide.

Dwarf Ash is a tree 15 to 20 feet high or a low spreading shrub, growing in desert washes or borders of desert streams. It occurs in the Providence Mountains of California (T. S.

Brandegee, 1902) and the Charleston Mountains of southern Nevada, ranging eastward to southern Utah, western Colorado and northern Arizona.

5. **Fraxinus dipetala** H. & A. FLOWERING ASH. Shrub 5 to 15 feet high; one-year-old shoots conspicuously 4-sided and 4-winged; leaves 2 to 6 inches long; leaflets 3 to 9, serrate above the middle, ¾ to 1½ inches long; petals 2, white, about 3 lines long; samaras 1 to 1¼ inches long, the wing frequently notched at tip.—Cañons or mountain slopes in both Sierra Nevada and Coast Ranges.

BIGNONIACEAE. BIGNONIA FAMILY.

Trees or shrubs, the leaves most commonly opposite and compound, in ours simple. Flowers large and showy, perfect, bilabiate. Stamens 4 in 2 pairs, the fifth stamen sterile or wanting. Ovary 2-celled, style 1; stigma 2-lobed. Valves of the fruit 2, falling away from the placentiferous partition and releasing usually winged seeds.—Large tropical order containing many lianes. Species of Bignonia, Tecoma and Catalpa are in garden cultivation in California.

1. CHILOPSIS Don.

Deciduous tree or shrub. Flowers in a short terminal raceme. Corolla funnelform, ventricose above, the ample limb bilabiate, 5-lobed. Stamens 4 and a sterile filament; anther-cells glabrous and diverging. Capsule long, linear, terete. Seeds oblong, thin, with the wing at each end replaced by a tuft of soft hairs.—(Greek cheilos, lip, and opsis, resemblance.)

Desert Willow.

1. CHILOPSIS SALIGNA Don.

Leaves opposite, whorled or mostly irregularly alternate, linear with lanceolate apex, entire, 1½ to 3 lines wide, 2 to 5 inches long, slightly grandular when old; corolla white and purplish, blotched with yellow in throat, 1 to 1¼ inches long, its rounded spreading lobes erose and undulate; capsule 6 to 12 inches long and 2 lines broad, with oblong thin seeds 4 lines long.

Desert Willow is a slender deciduous shrub or tree 10 to 20 feet high, with narrow crown and trunk 3 to 8 inches in diameter. Its common name is derived from its narrow willow-like leaves, although of course it is not in any way related to the willows. It grows along water-courses or washes in the Mohave and Colorado deserts of Southern California, westward to San Jacinto Valley, southward into Lower

California and northern Mexico, and eastward through southern Nevada and Arizona to western Texas. Its peculiar habit and showy flowers make it an interesting feature of the desert flora.

CAPRIFOLIACEAE. HONEYSUCKLE FAMILY.

Small trees or shrubs with opposite leaves. Flowers complete. Calyx-tube adnate to the ovary, the toothed limb insignificant. Corolla tubular or rotate, 4 or 5-lobed, regular or irregular. Stamens inserted on the corolla, as many as its lobes. Ovary 2 to 5-celled; style one. Fruit in ours a berry or berry-like drupe.—Ten genera, chiefly north temperate.

1. SAMBUCUS L. ELDERBERRY.

Shrubs or small trees with odd-pinnate leaves and serrate leaflets. Flowers small, white, in a terminal compound cyme, jointed with their pedicels. Calyx 5-toothed. Corolla regular, rotate, deeply 5-lobed. Ovary 3 to 5-celled; style short; stigmas 3 to 5; ovules solitary, suspended from the summit of each cell. Fruit small, globose berry-like drupes with cartilaginous nutlets.—About 20 species, represented in all continental areas. (Greek sambuke, a musical instrument, said to have been made of elder wood.)

Inflorescence flat-topped; berries black-purple with a blue bloom. .....
.....1. *S. glauca.*
Inflorescence ovate in outline; berries red.....2. *S. racemosa.*

Blue Elderberry.

1. SAMBUCUS GLAUCA Nutt. Fig. 117.

Leaves compound with 5 to 7 leaflets; leaflets coriaceous, glabrous, ovate to oblong-lanceolate, serrate except at the abruptly acuminate apex, 1 to 4 inches long; flowers small (2½ to 3½ lines broad), aggregated in a terminal flat-topped cluster 2 to 6 inches broad, consisting of one to several 5-rayed cymes; berry 2 lines in diameter, blue beneath the white bloom.

Blue Elderberry is a tree 15 to 28 feet high with roundish or irregular crown and trunk ½ to 1½ feet in diameter, or most commonly a roughish bush 5 to 10 feet high with several to many upright main stems. It ranges from Washington to Southern California, occurring in both the Sierra Nevada and Coast Ranges.

The bush-like clusters, which are common both in the valleys and mountains, may aspire to develop a single tree-like

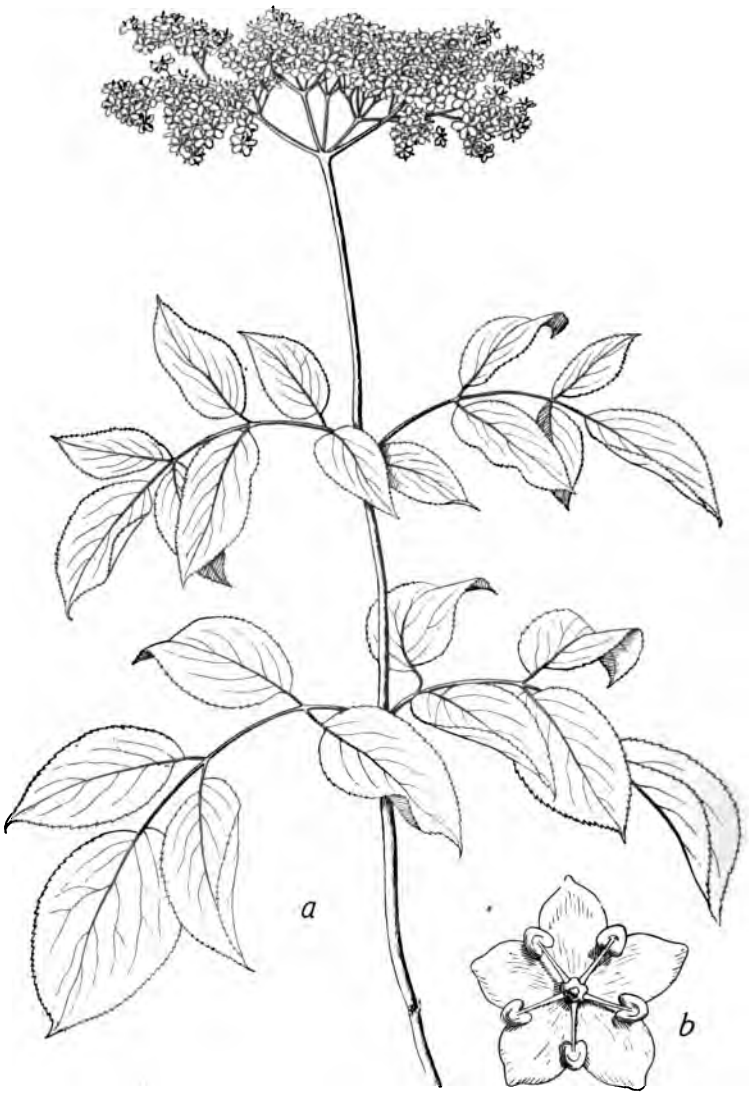

Fig. 117. BLUE ELDERBERRY (*Sambucus glauca* Nutt.). *a*, Flowering branch, ½ nat. size; *b*, flower from above, 9 times nat. size.

trunk, but rarely do so since the truly arboreous form is forestrally rare, such individuals being widely scattered or occurring in small clusters.

In late summer or winter Sambucus glauca is scraggly and unattractive on account of its habit of dying back. Its best season is early spring when the clumps round out full-foliaged heads which are truly attractive, as they are also a few months later when dowered with flowers.

The berries, often produced in great abundance, are used in rural cookery. Multitudinous jays, woodpeckers and other birds feed voraciously upon them and so distribute the seeds along fence lines in the valleys.

2. **Sambucus racemosa** L. RED ELDERBERRY. Low or many-stemmed shrub 2 to 5 feet high; leaflets 5 to 7, thin, oblong or obovate, abruptly acuminate, sharply serrate to the very apex, 2½ to 7½ inches long, 1 to 3 inches wide; flowers white in a thyrsoid-like panicle which is ovate in outline and 2 to 3 inches high; berries red, 2½ to 3 lines long.—High Sierra Nevada and far northward and eastward. Var. CALLICARPA Jepson. Arboreous, 12 to 25 feet high.—Bottom lands near sea on the north coast from Inverness to Usal.

ADDITIONS AND CORRECTIONS.

Page 46. JACK PINE. A name occasionally used to designate Tamrac Pine.

Page 46. JACK OAK. In the Sierra foothills this folk-name is applied to Quercus douglasii.

Page 68. PINUS SABINIANA Dougl. var. **explicata** Jepson n. var. Cones ovate, 8 inches long, 6 to 7 inches in diameter; lowest scales very long, slender and strongly curved; wing of the seed oblique on one edge, straight on the other edge, ½ inch long.—(Strobilis ovatis, 8 poll. longis, 6 ad 7 poll. in diametro, squamis infimis longis attenuatis curvatis, nuculis oblongis, ala ½ poll. longa).—Mt. Diablo, near head of Mitchell Cañon, W. L. J., no. 2649, Apr. 26, 1907.

Some years since there was published a new variety of the Coulter Pine from Mt. Diablo (var. DIABLOENSIS Lemmon, Sierra Club, Bull., vol. 4, p. 130,—1902) characterized chiefly by the short wings. But the Coulter Pine at Mt. Diablo has long

wings of the usual type, so far as I have been able to discover. It seems not unlikely that the author of the var. diabloensis may have had in hand the long-winged type of the Digger Pine here described and which is known as occurring only on Mt. Diablo.

Page 95. ABIES GRANDIS Lindl. The woodsmen of the north coast of California call this species "Stinking Fir," on account of the odorous sap.

Page 112. LIBOCEDRUS DECURRENS Torr. Commonly known to Sierra ranchers as Post Cedar or White Cedar.

Page 142. POPULUS TRICHOCARPA T. & G. Frequently called Balsam Cottonwood, or simply Balsam or Balm.

Page 154. QUERCUS LOBATA Neé. The trunks contain much sap; this sap is bluish, that is, it stains blue. While the trunks are as a whole worthless for timber, posts made from the butt cut which is hard, last a long time. I have known such posts to be in the ground thirty-two years and still sound.—S. C. Lillis.

This species is commonly known to the Spanish-Californians as Roble.

GEOGRAPHICAL INDEX.

Coast Ranges, the complex of ranges west of the Great Valley.

Gabilan Range, range east of the Salinas Valley from the Pajaro River south to the San Lorenzo Creek.

Great Valley, the great central valley of California, including the Sacramento and San Joaquin valleys.

Inner Coast Range, the range next to the Great Valley.

Klamath Range, the range forming the eastern boundary of Del Norte, of which Preston Peak is a great landmark; it is a southerly continuation of the Siskiyou Mountains.

Mayacamas Range, east of Ukiah Valley from Cobb Mt. and Geyser Peak northward to Cow Mt.

Mt. Hamilton Range, the range east of Santa Clara Valley from Livermore Valley south to Pacheco Pass.

Mt. Hood Range, the range west of Napa Valley.

Napa Mountains, the range east of Napa Valley.

North Coast Ranges, the ranges north of San Francisco Bay as far as the Siskiyous.

Palomar (sometimes known as Smith Mountain), San Diego County.

San Bernardino Mountains, the ranges from Cajon Pass easterly to Morongo Pass.

San Carlos Range, the inner South Coast Range from Panoche Pass south to Warthan Creek.

Santa Barbara Islands, collective name for all the islands off the coast of Southern California.

Santa Cruz Mountains, the range from Pajaro River north through San Mateo County to the San Bruno Hills.

Seaward Coast Range, the range next the ocean; applied more especially to the seaward North Coast Range.

Sierra Madre, the range from Cajon Pass westerly to the upper Santa Clara River, including the San Gabriel Mountains.

Sierra Nevada, the main mountain axis on the eastern side of the Great Valley, south to Tehachapi Pass and north to Pitt River.

South Coast Ranges, the ranges south of San Francisco Bay as far as Santa Barbara County (Santa Maria River).

Yollo Bolly Range, the inner North Coast Range from Snow Mountain north to North Yollo Bolly.

GLOSSARY.

Achene, a dry 1-seeded indehiscent fruit; strictly, one derived from a simple pistil.

Acorn, the fruit of an oak, consisting of nut and cup; cf. Figs. 85b, c and 99.

Acute, ending in an acute angle but not tapering or prolonged.

Adherent, same as adnate.

Adnate, said of different organs or parts which are grown together from the first.

Auricle, an appendage like the lobe of the ear.

Bilabiate, 2-lipped.

Blade, the expanded portion of a leaf or petal.

Bract, a modified or undeveloped leaf or scale-like organ subtending a flower or a flower-branch; a usually narrow and often minute structure subtending the cone-scale in coniferae (Figs. 60b, 63b and 54b).

Bur, a spiny fruit like that of a chinquapin or chestnut.

Caducous, dropping or falling early, especially in advance of other parts; falling easily.

Calyx, the outer usually green envelope of the flower.

Capitate, head-like (Fig. 101).

Capsule, a dehiscent fruit derived from a compound pistil.

Carpel, a simple pistil or one of the parts of a compound pistil.

Catkin, a densely flowered scaly spike which falls whole after flowering or after maturity (Fig. 75); also applied to the flowering cones in coniferae.

Caulicle, the stem of the plantlet (embryo) in the seed.

Choripetalous, with distinct petals.

Clavate, narrow and tapering gradually from base to apex; club-shaped.

Claw, the narrow or stalk-like base of a petal or sepal.

Coherent, same as Connate.

Complete flower, with all four circles.

Compound leaf, with the blade completely divided into several distinct parts or leaflets (Figs. 82 and 117).

Connate, said of similar parts more or less grown together.

Conduplicate, with the two sides or halves (as of a leaf) placed face to face.

Convolute, rolled up from one edge to the other.

Coriaceous, leathery.

Corolla, the inner usually colored envelope of the flower.

Corymb, a flat-topped flower-cluster, the outer flowers with longest pedicels and blooming first.

Crenate, with rounded teeth.

Crenulate, finely crenate.

Cuneate, wedge-shaped.

Cyme, a flat-topped flower-cluster, the central flowers opening first (compound cyme, Fig. 117).

Deciduous, barren of leaves in winter; falling after having performed its function (said of corollas and similar parts).

Decurrent, running down, as the blade extending down the petiole or on to the stem.

Deflexed, turned abruptly downward.

Dehiscent, splitting open.

Dentate, toothed with the teeth pointing straight out from the margin (Fig. 93).

Dilated, expanded or flattened, like the blade of a leaf.

Dimorphic, of two forms; compare dimorphic foliage of Redwood, Figs. 66 and 67.

Dioecious, with stamens and pistils in separate flowers on different plants.

Dorsal, the side turned away from the axis of growth; lower; inferior; back. cf. *ventral.*

Drupe, a fruit with two layers about the seed, the inner hard and stony, the outer fleshy.

Elliptical, a little longer than broad, and with curving margin; like an ellipse.

Emarginate, notched at apex.

Embryo, the plantlet in the seed.

Endosperm, the reserve tissue of the seed in which the embryo is usually embedded.

Entire, the margin whole and even, not toothed or lobed.

Epigynous, with corolla and stamens borne on the summit of the ovary or seemingly so.

Extrorse, situated on the outside or directed outwards.

Fascicled, in a bundle or close cluster.

Follicle, the fruit of a simple pistil opening by the inner or ventral suture.

Fruit, the matured product of the ovary with all its appendages; cf. Figs. 85b, c, 99, 100, 102, 106, 110, 115a, 116b.

Glabrous, bald, destitute of hair. Compare *smooth.*

Hypogynous, borne on the receptacle.

Imbricated, overlapping like shingles on a roof.

Incised, deeply and sharply cut as if slashed.

Indehiscent, not splitting open.

Inferior ovary, one which is not free; one adnate to the calyx.

Inflorescence, a flower-cluster; mode of flower arrangement.

Introrse, situated on the inside or directed inwards.

Involucre, a circle of bracts.

Involute, rolled in from each edge (Fig. 80).

Irregular, with the parts of different size or shape.

Lanceolate, lance-shaped, narrow and tapering gradually to a point (Fig. 76b).

Leaflet, one of the divisions of a compound leaf (Fig. 82).

Legume, a 1-celled pod opening by both ventral and dorsal sutures, like a pea pod.

Line, $\frac{1}{12}$ of an inch.

Linear, 4 or 5 times as long as broad and with parallel or nearly parallel sides.

Membranous, thin, semi-transparent.

Moniliform, like a rosary (Figs. 103c, d).

Monoecious, with stamens and pistils in separate flowers on the same plant.

Nutlet, a small hard indehiscent 1-seeded fruit, usually derived from a compound pistil.

Oblique, developed more on one side than the other; not symmetrical.

Oblong, two or three times as long as broad and with parallel or tapering sides.

Orbicular, circular.

Ovary, the dilated or enlarged base of the pistil which contains the ovules.

Ovate, broad and tapering to a narrow apex; egg-shaped.

Ovoid, egg-shaped.

Ovule, the embryonic seed contained in the ovary.

Palmate, divided or lobed like the fingers of a hand (Figs. 100 and 111).

Panicle, a compound or branching raceme.

Parietal, placed on the side.

Pedicel, stalk of an individual flower or fruit.

Peduncle, stalk of a flower-cluster or cone.

Peltate, borne centrally beneath.

Perigynous, with corolla and stamens borne on the calyx.

Petal, a division or "leaf" of the corolla.

Petiole, the stalk of a leaf.

Pinnate, with the leaflets disposed along the two sides of a common axis (Figs. 82 and 117).

Pistil, the female organ of the flower.

Placenta, specialized tissue in the ovary which bears ovules.

Pollen, the fertilizing powder borne in the anthers.

Polygamous, with perfect and with either or both male and female flowers on the same or on different individuals.

Pome, a fleshy inferior fruit like an apple.

Pubescent, hairy with fine close hairs.

Punctate, dotted.

Raceme, having flowers with pedicels of about equal length disposed along a common axis and flowering from below upward.

Receptacle, the much abbreviated and modified stem which bears the various flower circles.

Regular, with the parts equal and of the same shape.

Reniform, kidney-shaped.

Revolute, rolled under or back from the edge.

Samara, an indehiscent pod with a long wing (Fig. 116b); double samara, two united pods, each with a long wing (Fig. 110).

Sepal, a division or "leaf" of the calyx.

Serrate, toothed like a saw with upwardly pointed teeth.

Serrulate, finely serrate (Figs. 76b and 81).

Sessile, without petiole, peduncle, or stalk; literally seated.

Sinuate, lobed with rounded recess (Fig. 87).

Smooth, not rough. cf. *glabrous.*

Spathe, differentiated bract-like leaf enclosing a flower-cluster.

Spike, a raceme in which the flowers are sessile.

Stamen, a male organ of the flower producing the pollen.

Staminodia, sterile stamens, usually scale-like.

Stigma, that portion of the style destitute of epidermis and fitted to receive and bring about the growth and development of the pollen-grains.

Stipitate, elevated on a slender stalk, as a stipitate gland.

Stipule, the appendages at the base of a petiole, one on each side.

Style, a slender often elongated organ connecting ovary and stigma.

Sub-, prefix meaning somewhat or approaching.

Subulate, awl-shaped.

Superior ovary, one which is free from or not adnate to the calyx.

Sympetalous, with united petals.

Synsepalous, with united sepals.

Terete, slenderly cylindric, circular in cross-section.

Thyrse, a contracted compact ovate panicle, one in which the middle branches are larger than those above and below as in the lilac and grape.

Tomentose, woolly.

Tomentum, wool.

Tree, a woody plant with distinct trunk and crown, commonly 20 feet high or more.

Truncate, cut off abruptly.

Umbel, a flat-topped flower-cluster with the pedicels of equal length and flowering from the outside towards the inside.

Umbilicate, with a central depression or umbilicus.

Umbo, with a central protuberance or point (the cone-scales in Figs. 41 and 44 have a prickly umbo).

Undulate, wavy.

Ventricose, puffed out or distended on one side.

Ventral, the side nearest the axis of growth; upper; superior; face. cf. *dorsal.*

Villous, with soft hairs.

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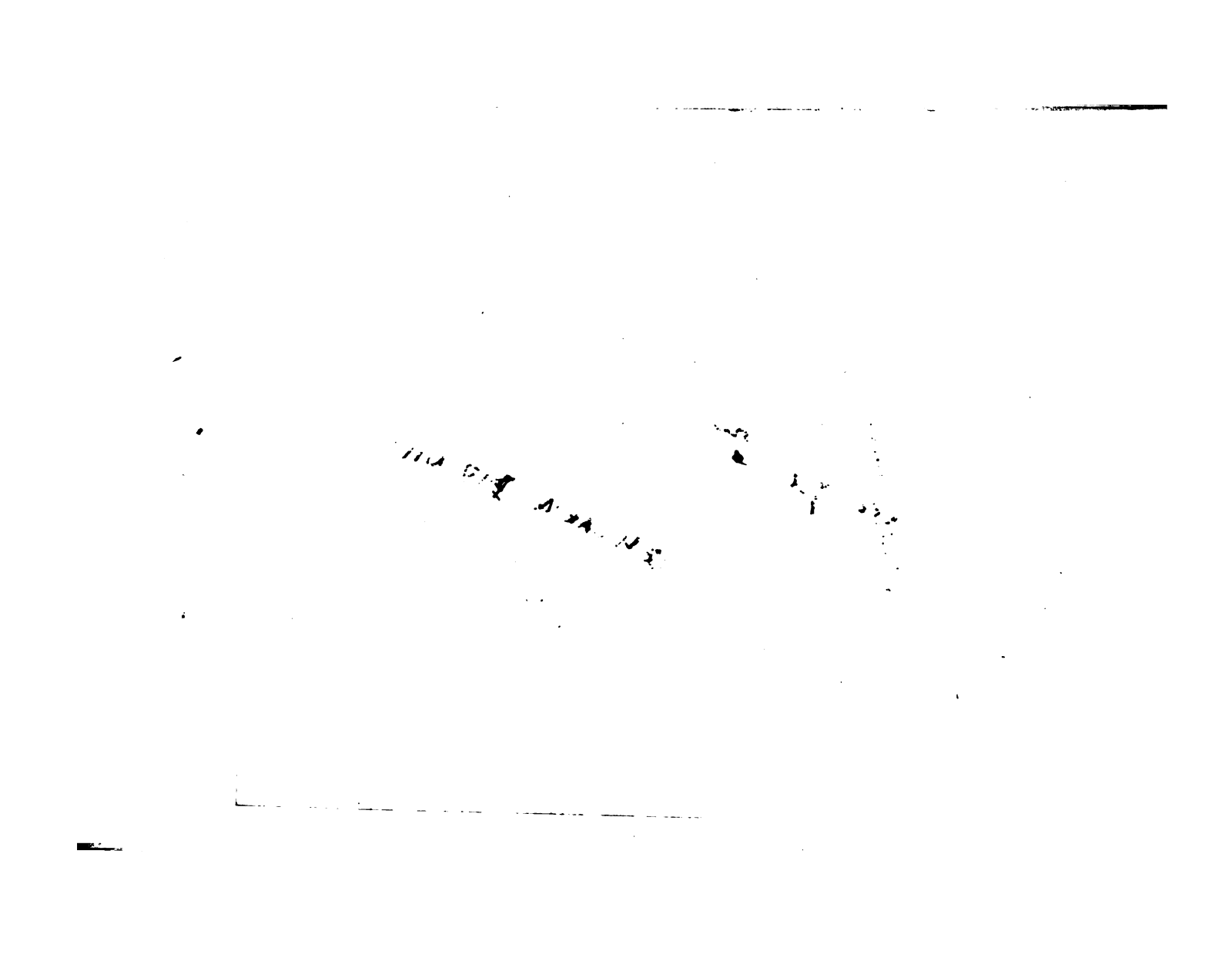
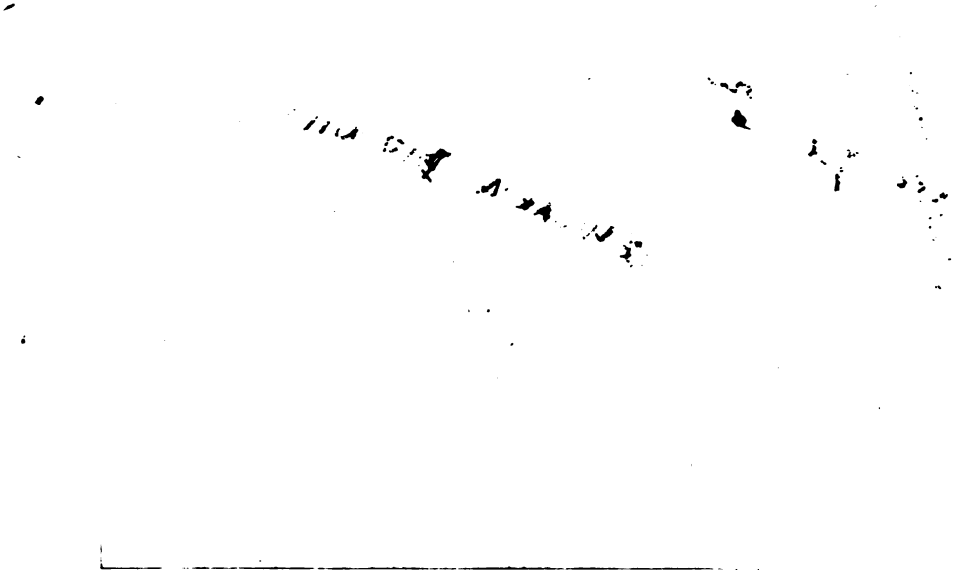
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